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NOTE BY THE SECRETARY-GENERAL

The Secretary-General has the honour to transmit to the members of the Security Council the attached letter dated 6 October 1997, which he has received from the Director General of the International Atomic Energy Agency (IAEA).

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Annex

Letter dated 6 October 1997 from the Director General of the International Atomic Energy Agency to the Secretary-General

In paragraph 16 of resolution 1051 (1996) of 27 March 1996, the Security Council called for the consolidation of the periodic requirements for progress reports under resolutions 699 (1991), 715 (1991) and resolution 1051 (1996), and requested the Director General to submit such consolidated reports every six months to the Council, commencing on 11 April 1996.

The fourth such report, which is enclosed herewith, consists of part one, which provides a description of the work carried out and discussions held during the period 1 April 1997-1 October 1997, and part two, which provides an overview of the activities of the International Atomic Energy Agency to date in implementing its obligations under paragraph 13 of Security Council resolution 687 (1991).

I request that you kindly transmit the enclosed report to the President of the Security Council. I remain available for any consultations that you or the Council may wish to have.

(Signed) Hans BLIX
Director General

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Appendix

Fourth consolidated report of the Director General of the International Atomic Energy Agency under paragraph 16 of Security Council resolution 1051 (1996)

INTRODUCTION

1. In paragraph 16 of resolution 1051 (1996), adopted on 27 March 1996, the Security Council called for the consolidation of the periodic progress reports required under resolutions 699 (1991), 715 (1991) and 1051 (1996), and requested the Director General of the International Atomic Energy Agency (IAEA) to submit such a consolidated report every six months to the Council, commencing on 11 April 1996.

2. The Director General submits herewith the fourth[1] such consolidated report under paragraph 16 of resolution 1051 (1996).

3. Part one of the report provides a description of the work done by the IAEA, during the period 1 April 1997 to 1 October 1997, in implementation of its plan for the ongoing monitoring and verification of Iraq's compliance with paragraph 12 of resolution 687 (1991), and includes an extensive summary of the technical discussions held between the IAEA and Iraq and the verification activities undertaken by the IAEA, during the reporting period, with respect to the IAEA's review of Iraq's "Full, Final and Complete" declaration. A summary of part one is set out in paragraphs 39 to 44 of the report.

4. Part two of the report provides an overview of the activities undertaken by the IAEA since it began the implementation of its obligations, under paragraph 13 of resolution 687 (1991), to carry out on-site inspection of Iraq's nuclear capabilities and to destroy, remove or render harmless any nuclear weapons, nuclear-weapon-usable material, their subsystems and components and any related research, development, support or manufacturing facilities. It was thought that such an overview would be useful to the Security Council. Attachments 1-4 to the report provide detailed supplementary information. A summary of part two is set out in paragraphs 73 to 83 of the report.

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[1] The previous consolidated reports of the Director General of the IAEA were circulated as document S/1996/261 on 11 April 1996, as document S/1996/833 on 7 October 1996 and as document S/1997/297 on 11 April 1997.

Part One

PROGRESS REPORT FOR THE PERIOD 1 APRIL 1997 to 1 OCTOBER 1997

Inspection activities

5. In the period under review (1 April 1997-1 October 1997), the IAEA Nuclear Monitoring Group (NMG) carried out 250 monitoring inspections at some 90 locations, of which 11 inspections were carried out at locations not previously inspected. The total number of ongoing monitoring and verification (OMV) inspections carried out to date now exceeds 1,000. The majority of these were carried out with no prior announcement, and a number of them were conducted in co-operation with the Special Commission (UNSCOM) monitoring groups. No indication of prohibited materials or activities was detected during these inspections. As regards prohibited equipment, the Iraqi counterpart has handed over to the IAEA a number of pieces of weaponisation-related equipment which it had located in response to repeated requests by the IAEA. This equipment is being removed from Iraq.

6. The ninth radiometric survey of Iraq's main watercourses was carried out from 11 to 21 April 1997. The results of this and previous surveys have shown no indication of Iraq having carried out any proscribed nuclear activities, but they have confirmed the sensitivity of the technology by detecting Iraq's permitted use of radioisotopes in medical applications.

7. Other NMG activities included interviews of key personnel formerly employed in Iraq's clandestine nuclear programme; the equipping of the NMG environmental sample screening laboratory, located in the Baghdad Monitoring and Verification Centre; and, with the support of the Governments of France, Chile and Germany, the reintroduction of aerial radiometric surveys. The aerial radiometric survey was carried out in May over a period of 17 days and included more than 20 locations covering an area of more than 140 square kilometres. With the assistance of member States, the IAEA continues to improve the capabilities of its OMV activities by the introduction of improved technology, with particular regard to improved equipment for aerosol sampling and fixed-point and land-vehicle-based radiometric surveys.

8. The IAEA and UNSCOM have continued their implementation of a joint programme of inspection of Iraqi sites which, in the judgement of IAEA/UNSCOM, are deemed to have capabilities suitable for conducting work on some aspect of weapons of mass destruction, notwithstanding the lack of evidence or indication of such work. The carrying out of joint IAEA/UNSCOM multi-disciplinary inspections at "capable" sites on a regular basis continues to contribute to the effectiveness of the OMV to detect any attempt by Iraq to conduct activities proscribed by Security Council resolutions. Since the adoption of this IAEA initiative, in 1996, more than 40 inspections at "capable" sites - mostly co-ordinated by the IAEA - have been conducted by joint IAEA/UNSCOM teams. No indication of prohibited equipment, materials or activities has been detected. Other joint UNSCOM/IAEA activities have included investigations of procurement-related matters and document examination.

9. The NMG also completed the second of its two-phased verification of activities in connection with Iraq's declared destruction and concealment of material and equipment related to its clandestine nuclear programme. The first phase of these verification activities involved searches at three sites to the south of Lake Tharthar, using sub-surface sensing technologies provided and implemented by a supporting member State, which facilitated the location, excavation and identification of buried items (particularly metallic items). The material and equipment recovered at the Tharthar sites originated from Iraq's past gaseous diffusion and gas centrifuge uranium enrichment programmes. The number and nature of items found appear to be consistent with the statements made by Iraq in its "Full, Final and Complete Declaration" of its nuclear programme (FFCD). As previously declared by Iraq, the bulk of the recovered equipment had been destroyed. However, there was also a large number of specialised, high-value, corrosion resistant valves which were in "as new" condition. According to the Iraqi counterpart, these valves had been purchased for potential use in centrifuge cascade circuits.

10. The second phase of the search and excavation activity was completed in May with the survey of nine other sites. The activity at three sites consisted of post-excavation surveys to verify that no materials remained buried at the sites. The principal site in this category was the Tuwaitha Fire Station burial site. The material and equipment at this site were removed in April 1997 and identified by the Iraqi counterpart as ancillary equipment belonging to electromagnetic isotope separation (EMIS) development projects. The material and equipment found at the Tuwaitha Fire Station burial site is considerably less than Iraq has stated to have been buried at that location. Consequently, Iraq was asked to continue the search and to locate certain items which, though general purpose in nature, comprise, *inter alia*, components of systems for the conversion of uranium which are proscribed under annex 3 of the IAEA's OMV plan. The Iraqi counterpart extended the search area around Tuwaitha and has located and made available many such items, most of which had evidently been destroyed, as had been declared by Iraq. The activity at the six other sites consisted of both survey and excavation. At one of these sites (Al Amil Liquid Nitrogen Plant), the excavation revealed a small number of previously undeclared EMIS components.

Iraq's "Full, Final and Complete Declaration"

11. On 7 September 1996, Iraq submitted what it considered to be the definitive version of the "Full, Final and Complete Declaration" (FFCD-F) of its clandestine nuclear programme, as required by paragraph 3 (i) of Security Council resolution 707 (1991). This version was produced following discussions between the IAEA and the Iraqi counterpart in May and June/July 1996 and included annexes detailing equipment and procurement-related matters. FFCD-F was reviewed by the IAEA, in consultation with member State experts, and by letter of 13 January 1997, the Iraqi counterpart was notified of the need for a number of additions and revisions to the declaration.

12. The Iraqi counterpart's response, by a letter of 27 January 1997, was discussed in a series of meetings held in Iraq in February 1997. In these meetings it was agreed that the Iraqi counterpart would provide a consolidated list of additions and revisions which, after review by the IAEA, would be

incorporated into the text of FFCD-F. By a letter of 26 February 1997, Iraq provided a "consolidated list", which was reviewed, again in consultation with member State experts, and was discussed with the Iraqi counterpart during an IAEA technical team visit to Iraq from 16 to 22 May 1997. In addition to the discussion of specific technical matters, the Iraqi counterpart was advised that, while FFCD-F had set out to describe in detail what had been constructed, procured and operated within Iraq's nuclear programme, the document would benefit greatly from the inclusion of a section describing the practical and theoretical achievements of Iraq's clandestine nuclear programme, with particular respect to the capabilities developed by the end of the programme.

13. As a result of these discussions, the Iraqi counterpart provided, on 9 July 1997, a number of revisions and additions, which were further discussed during an IAEA technical team visit to Iraq from 19 to 24 July 1997. The revisions and additions resulting from the July discussions were received by the IAEA during the period 3 to 14 August. They do not include the summary of achievements referred to above.

Technical team visit, 16 to 22 May 1997

14. As reported above, a technical team of IAEA personnel and member State experts visited Iraq from 16 to 22 May 1997 to review Iraq's additions and revisions to FFCD-F. The discussions with the Iraqi counterpart addressed a number of technical questions and the role of the General Intelligence Service (Mukhabarat) in clandestine procurement. However, it focused primarily on presentations that the Iraqi counterpart had been asked to make on three subjects which continued to be of concern to the IAEA, namely:

- The evolution of Iraq's strategy for the protection, concealment, salvaging and unilateral destruction of materials, equipment, documents and buildings related to its clandestine nuclear programme. The counterpart was asked to cover the details of the actual removal, transfer, concealment, destruction and redistribution of materials and equipment as outlined in the annex to FFCD-F.

- The progress in the design and development of the Iraqi nuclear weapon after the version reported in Petrochemical Project 3 (PC-3) Report 821, Revision 5, dated 14 July 1990, and the post-war plan to misrepresent the mission of the Al Atheer nuclear weapons development and production facility.

- The evolution of the abandonment of the former nuclear weapons programme.

The IAEA had previously asserted that official documentation must exist recording the dissolution and reassignment of the facilities and resources of Iraq's clandestine nuclear programme. In response, the Iraqi counterpart had provided a number of documents to this effect. The counterpart was asked to provide, through its presentation, fuller explanation and additional documentation to support its declared abandonment of the programme. In this latter regard, it had also been expected to obtain an understanding of the objectives, scope and duration of the assumed attempts by the late Lt. General "Hussein Kamel and his group" to sustain the nuclear programme beyond

April 1991. However, the Iraqi counterpart claimed to be unable to provide any information regarding the objectives of Hussein Kamel.

15. In discussions on clandestine procurement, the Iraqi counterpart initially stated that Mukhabarat had played no role in these activities. However, when presented with documented examples of the Mukhabarat's involvement, the Iraqi counterpart agreed to investigate the matter and provide a further response. In returning to the subject in later discussion, the counterpart explained that the Mukhabarat had been involved in clandestine procurement activities, but that its role had been so minor that it had been forgotten. The counterpart further explained that out of a total of some thirty procurement contracts routed through the Mukhabarat's front company, "Technical Consultations Company", only seven had been fulfilled. Summary information on these consignments was provided to the IAEA.

16. In associated discussions about the handling of solicited and unsolicited offers of foreign assistance to Iraq's clandestine nuclear programme, including the role played by the Mukhabarat, the Iraqi counterpart stated that Petrochemical-3 project (PC-3) had adopted a policy of avoiding foreign assistance, believing that the risk of exposure (e.g., through "sting" operations) far outweighed the likely technical benefits. The counterpart stated that it was unable to recall any offers of significant assistance and was told that this matter would be raised again in the future.

17. The presentations resulted in considerable discussion, although little new information was forthcoming. Nonetheless, the Iraqi counterpart undertook to use the input from the discussions to expand and correct the addenda to FFDC-F describing the movement, concealment and unilateral destruction of materials, equipment, buildings and documentation. The IAEA was also provided with copies of additional orders and decrees establishing and defining the mission of the facilities that resulted from the dissolution of PC-3.

18. Following from the discussions on the presentations and other technical matters, the Iraqi counterpart also agreed to provide further modifications to the text of FFCD-F and also undertook to make a serious attempt to locate and make available: the equipment formerly assigned to departments 40B and 40G of PC-3 Group 4 (weaponisation); PC-3 reports relating to indigenously produced uranium melting furnaces and the study on the feasibility of falsely representing the Al Atheer weapons plant as a materials characterisation centre; facility-specific inventories of materials and equipment handed over to and recovered from military authorities in connection with concealment and unilateral destruction activities; and data indicating the stage of development of weapons components at the time the programme was abandoned.

19. In addition, the counterpart was asked to provide information regarding the inauguration, mandate, membership, authority and duration of operation of the Governmental Committee that had been referred to, during the first presentation, as having been established, *inter alia*, to "reduce the effect of NPT violation to the minimum".

Technical team visit 19 to 24 July 1997

20. In its communication of 9 July 1997, the Iraqi counterpart provided written responses in partial fulfilment of the aforementioned agreed actions, and indicated its readiness to discuss the remaining items. Consequently, a technical team of IAEA personnel and member State experts visited Iraq from 19 to 24 July 1997. The technical team had two objectives. The first was to seek clarification of the additions and revisions to the FFCD-F that had been provided by the counterpart. The second was to seek to ascertain that:

- Iraq had abandoned, rather than merely interrupted, its clandestine nuclear programme.

- Iraq had provided comprehensive information with respect to its gas centrifuge uranium enrichment programme, its nuclear weapon design and its achievements in associated technologies.

- Iraq had explained the full extent of foreign assistance to its clandestine nuclear programme, including the role of intelligence services in procuring assistance, information, materials, and equipment.

- Iraq had provided a comprehensive explanation of the extent and objectives of its concealment practices.

- Iraq is no longer concealing equipment, materials and documentation from the IAEA.

21. The Iraqi counterpart had achieved a significant measure of success in completing its undertaking, made in May 1997, to locate the equipment formerly assigned to Departments 40B and 40G of PC-3 Group 4 (weaponisation). The equipment located was made available for IAEA inspection at the Al Shakili store where it had been accumulated, having been retrieved as a result of an extensive search at many facilities. The IAEA agreed to give priority to its assessment of the equipment recovered and to indicate remaining items which needed to be found.

22. On the other hand, the Iraqi counterpart reported lack of success in locating the requested PC-3 reports. However, the counterpart provided a verbal explanation of a report relating to the planned indigenous production of a uranium melting furnace based on electron-beam technology. The counterpart also expanded upon its earlier explanation of the pamphlet that had been produced to support the misrepresentation of the Al Atheer facility which had resulted from the study recorded in the missing PC-3 report - "Feasibility of the Material Centre". The Iraqi counterpart stated that the pamphlet provided an accurate summary of the missing report.

23. The Iraqi counterpart was able to produce a 62 page computer print-out detailing the items of material and equipment, essentially from PC-3 Group 2 and Group 3, that had been handed over to the Special Guard in early 1991 and those items (approximately 70% of the total) which had been recovered subsequently from the destruction, evacuation and storage sites and made available for inspection by IAEA teams following the visit of the high-level mission in

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June 1991. These data substantiate the summary information contained in a letter dated 13 September 1991 from Dr. Jafar Dhia Jafar, in his capacity as Deputy Minister of Industry and Military Industrialisation, to his supervising Minister Lt. General Hussein Kamel, a copy of which was provided to the IAEA by the Iraqi counterpart in November 1995. These data do not, however, cover the fate of materials and equipment formerly belonging to PC-3 Group 4 located in Al Atheer and that of the uranium centrifuge enrichment group (EDC).

24. With respect to the achievements of the gas centrifuge uranium enrichment programme, the Iraqi counterpart maintained that its primary objective had been to exploit the tested, prototype single cylinder model, and that all resources had been directed toward this objective. The counterpart reiterated that the small amount of work that had been done with a view to exploiting the design drawings of super-critical two-cylinder and multi-cylinder centrifuge designs had been a "spare time" study, which had achieved little of consequence. It was explained that this study had been biased towards the more complex, multi-cylinder, design simply because there were more design details available for that machine. The Iraqi counterpart reaffirmed that, although it would have eventually sought to exploit higher efficiency centrifuge designs, the primary goal had been the large-scale exploitation of the single cylinder machine, which it considered to be a proven design. The counterpart further stated that the modifications which had been made to buildings at Al Furat and EDC Rashdiya were very much forward-looking and should not be taken to imply that hopes of early exploitation of multi-cylinder centrifuge designs had been seriously entertained.

25. The Iraqi counterpart stated that it had been unable to locate any additional documentation that might have indicated the extent of development of the nuclear weapon and associated technologies at the time of programme abandonment. The counterpart volunteered an explanation of the sequence of drawings of moulds for the casting of explosive lens components, but was unable to provide a verifiable explanation of the missing drawings. Attempts made by the counterpart, during the visit of the technical team, to locate the drawing register, which should have recorded the title of each drawing, were also declared to be unsuccessful.

26. A summary, prepared by the IAEA, of information previously provided by the Iraqi counterpart relating to the re-assignment of facilities formerly belonging to Iraq's clandestine nuclear programme was discussed and the counterpart undertook to provide copies of further orders and decrees that were necessary to substantiate the stated re-assignments.

27. A revised chronology prepared by the Iraqi counterpart of the actions taken by Iraq in connection with the collection, concealment, unilateral destruction and eventual relocation of material and equipment was discussed in detail and the Iraqi counterpart undertook to further clarify the information. The draft of a similar chronology regarding documentation was also tabled. It was agreed that this document would be further reviewed by the counterpart before it was provided to the IAEA.

28. During the meeting concluding the technical talks in July 1997, the IAEA identified some 15 technical matters, of varying significance, requiring action

by the Iraqi counterpart. By a letter of 1 August 1997, the IAEA notified the Iraqi counterpart of five areas of concern with respect to which it considered that further information should be made available, namely: the development, over time, of Iraq's strategy for concealment and unilateral destruction of materials, equipment and documentation, including the role of the Governmental Committee; the extent of external (foreign) assistance to the clandestine nuclear programme; the final achievements in the design of the nuclear weapon and associated technologies; the chronology of the abandonment of the clandestine nuclear programme; and post ceasefire covert procurement activities. By this same letter, Iraq was reminded of the observation, made during the May 1997 technical talks, that the FFCD would benefit greatly from a section describing the practical and theoretical achievements of Iraq's clandestine nuclear programme, with particular respect to the capabilities developed by the end of the programme.

29. In the period 4 August to 16 September 1997, Iraq issued a series of 24 letters responding to these matters. In most instances the written responses contained little new information but provided a helpful collation of previously reviewed information. In one critical area, Iraq was able to provide copies of correspondence which, if genuine, provide strong corroboration of Iraq's description of the status as of the end of 1990 of its work to develop explosive lenses. Iraq also provided written authority to the IAEA to take possession of and dispose of materials and equipment for the production of gas centrifuge carbon fibre composite cylinders, currently detained in Jordan. Iraq has also undertaken to provide information regarding its post-war procurement modalities.

30. Although providing substantial revisions and additions to previously supplied information regarding the concealment and unilateral destruction of materials, equipment and documentation, Iraq has not explained the development, over time, of the underlying strategy for such actions, but has stated simply that its activities in this regard were ad hoc reactions to rapidly changing situations. Similarly, Iraq has not provided a clear and comprehensive statement of the role of the Governmental Committee declared to have been established in June 1991 and charged, *inter alia*, to "reduce the effect of NPT violation to the minimum". Furthermore, Iraq has stated that it has declared all aspects of external assistance to its clandestine nuclear programme, and has declined to provide the proposed additional FFCD section describing the practical and theoretical achievements of Iraq's clandestine nuclear programme.

31. Iraq continues to claim that it is unable to shed light on the motives of "Hussein Kamel and his group" in concealing the materials, equipment and documentation handed over to IAEA/UNSCOM at the Haider House farm in August 1995.

Declarations under the OMV plan

32. Paragraph 22 and annex 2 of the OMV plan (document S/22872 Rev.1 and Rev.1/Corr.1) require Iraq to provide semi-annual declarations in January and July on the current use of facilities, installations and sites, including those formerly involved in its clandestine nuclear programme and on changes during the previous six months regarding the inventory and location of materials, equipment and radioisotopes identified in annexes 3 and 4 of the plan.

33. With the co-operation of the Iraqi counterpart, further progress has been made regarding the content and accuracy of these declarations. In particular, the Iraqi National Monitoring Directorate (NMD) responded to the IAEA request to include supplementary information on current activities at certain sites involved in the production of materials, equipment and components, as well as sites involved in design and in research and development work. The supplementary information, which also includes detailed descriptions of the current usage of the declared equipment and materials, is intended to assist the IAEA in improving the efficiency of its monitoring and verification activities in Iraq.

34. The IAEA has evaluated the declarations received in July 1997 and will follow up, with the Iraqi counterpart, requirements for further improvements to the accuracy and completeness of the declarations in the course of its routine OMV activities.

35. Iraq has not yet advised the IAEA of its enactment of penal laws to enforce the prohibition on all natural and legal persons under Iraq's jurisdiction or control from undertaking anywhere any activity that is prohibited for Iraq by relevant Security Council resolutions or by the IAEA's OMV plan, as required pursuant to paragraph 34 of the IAEA's OMV plan.

Release, relocation and change of use of equipment, material and facilities

36. In the period under review, the NMD submitted twenty-nine requests to the IAEA for approval of the release/relocation of equipment and materials or of the change of use of monitored buildings. Such requests are processed in consultation with the Special Commission. Twenty-seven of the twenty-nine requests have been approved. Items for which release, relocation or change of use is approved remain subject to ongoing monitoring and verification at a frequency commensurate with their significance.

Export/import mechanism

37. The export/import monitoring mechanism for Iraq, jointly administered by UNSCOM and the IAEA, has, since October 1996, received notifications of some 50 transactions involving the intended export to Iraq of items identified in the Annexes to the respective OMV Plans. None of these notifications involved items identified in annex 3 of the IAEA OMV plan.

High-level talks

38. As previously reported, during discussions on the occasion of the visit of Iraq's Minister of Foreign Affairs, Mohammed Said Al-Sahaf, to IAEA Headquarters on 7 March 1997, the Director General raised the subject of Iraq's requirement to reaffirm unconditionally its obligations under the NPT. In a letter, addressed to the Director General and dated 1 May 1997, Iraq's Foreign Minister, wrote:

> "... I am pleased on this occasion to reaffirm once again the obligations of the Republic of Iraq without limitation or condition under the NPT and full compliance with the agreement signed with the IAEA on the safeguards regime."

Summary

39. The IAEA continues with implementation of its OMV plan and has embarked upon a programme to update the technology used in its monitoring activities. This has already resulted in the implementation of sub-surface sensing techniques and the further development of routine aerial and land-based radiometric surveys. Work in other areas of technology is being actively pursued with the help of member States.

40. In the course of discussions, the Iraqi counterpart has provided a response to IAEA questions but, from the IAEA perspective, the questions were often construed as narrowly as possible and responses addressed only inaccuracies or omissions that the IAEA had specifically identified in the text. This minimalist approach has resulted in the expenditure of considerable additional time and effort, for all concerned, to produce improvements to FFCD-F. More detailed consideration of the matters reported in paragraphs 11 to 31 above are included in part two of this report and summarised in paragraphs 73 to 83.

41. In response to IAEA requests, the Iraqi counterpart has invested considerable effort in the provision of equipment and personnel resources to support IAEA search and excavation activities to locate and verify the status of materials and equipment declared by Iraq to have been destroyed, either as a result of the Gulf War bombardment or by Iraq's unilateral actions. Also, with the co-operation of the Iraqi counterpart, further progress has been made, in the content and accuracy of Iraq's six-monthly declarations under the OMV. In particular, the July 1997 declarations include supplementary information, requested by the IAEA, on current activities at certain sites involved in the production of materials, equipment and components, as well as sites involved in design and in research and development work. The IAEA is evaluating the most recent declarations and will identify requirements for further improvements.

42. The 1 May 1997 letter from Iraq's Minister of Foreign Affairs resulting from his discussion with the Director General is understood by the IAEA to reflect not only Iraq's unconditional reaffirmation of its obligations under the NPT, but its acceptance of its obligations, as interpreted by the IAEA, under Iraq's Safeguards Agreement with the Agency.

43. The IAEA's ongoing monitoring and verification activities carried out since April 1997 have not revealed indications of the existence in Iraq of prohibited materials or activities. As regards prohibited equipment, the Iraqi counterpart has handed over to the IAEA a number of pieces of weaponisation-related equipment which it had located in response to repeated requests by the IAEA. This equipment is being removed from Iraq.

44. In carrying out its activities in Iraq, the IAEA has benefited from the assistance and co-operation of the United Nations Special Commission and, in particular, from the generous support of certain IAEA member States which have

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provided technical personnel resources, access to advanced technologies and access to information.

Part Two

OVERVIEW OF IAEA ACTIVITIES REGARDING THE IDENTIFICATION AND DESTRUCTION, REMOVAL AND RENDERING HARMLESS OF IRAQ'S CAPABILITIES RELATED TO NUCLEAR WEAPONS

Background

45. In paragraph 12 of resolution 687 (1991) the Security Council decided that Iraq shall unconditionally agree: not to acquire or develop nuclear weapons or nuclear-weapon-usable material or any subsystems or components or any research, development, support or manufacturing facilities; and to submit to the Secretary-General and the Director General of the IAEA within fifteen days a declaration of the locations, amounts and types of all such items.

46. It further decided that Iraq shall unconditionally agree: to place all of its nuclear-weapon-usable materials under the exclusive control, for custody and removal, of the IAEA; to accept urgent on-site inspection and the destruction, removal or rendering harmless as appropriate of all items specified; and to accept the IAEA plan for the future ongoing monitoring and verification of its compliance with those undertakings.

47. In paragraph 13 of that same resolution, the Security Council requested the Director General of the IAEA: to carry out immediate on-site inspection of Iraq's nuclear capabilities; to develop a plan for submission to the Security Council within forty-five days calling for the destruction, removal, or rendering harmless as appropriate of Iraq's nuclear weapons or nuclear-weapon-usable material or any related subsystems or components or any related research, development, support or manufacturing facilities; and to carry out the plan within forty-five days following approval by the Security Council.

48. The Director General was also requested to develop a plan, taking into account the rights and obligations of Iraq under the Treaty on the Non-Proliferation of Nuclear Weapons of 1 July 1968, for the future ongoing monitoring and verification of Iraq's compliance with paragraph 12 of resolution 687, including an inventory of all nuclear material in Iraq subject to the Agency's verification and inspections to confirm that Agency safeguards cover all relevant nuclear activities in Iraq, to be submitted to the Security Council for approval within one hundred and twenty days of the date of adoption of the resolution. As will be readily understood from the following paragraphs, it was not possible for the IAEA to follow such a timetable, primarily because Iraq chose to follow a course of denial, concealment and obstruction, rather than meeting its obligation to provide, at the outset, the declaration foreseen by resolution 687.

49. On 18 April 1991, Iraq submitted to the IAEA a declaration that it had no nuclear weapons or materials or equipment or facilities of the nature defined in

paragraph 12 of the resolution. The IAEA, in a letter dated 19 April 1991, advised Iraq that it was obliged to declare all fissionable material which could be used in the manufacture of a nuclear explosive device, including separated plutonium, uranium enriched to 20% or more in the isotope U235 (highly enriched uranium) and U233. It further advised Iraq that it was also obliged to declare facilities such as those for the reprocessing of nuclear fuel or for the separation of plutonium from uranium, or installations for the separation of isotopes of uranium, as well as any research programmes or supporting manufacturing facilities related to such activities.

50. On 27 April 1991, Iraq submitted a selective declaration of its inventory of nuclear material which was limited to the material previously declared by Iraq pursuant to its safeguards agreement with the IAEA. This declaration included some nuclear material which was not weapon-usable but did not include much larger amounts of other non-weapon-usable nuclear materials which had been clandestinely acquired or produced.

51. Iraq's declaration also listed 23 buildings on the Tuwaitha site of the Iraqi Atomic Energy Commission, as well as the uranium yellowcake production facility at Al Qaim. However, the declaration failed to include the uranium dioxide and uranium tetrachloride plants at Al Jesira, the electromagnetic isotope separation (EMIS) uranium enrichment facilities at Al Tarmiya and Al Sharqat, the nuclear weapons development and production facilities at Al Atheer and Al Qa Qaa and the gas centrifuge uranium enrichment facilities at Al Rashdiya and Al Furat or any of the engineering, manufacturing and support facilities.

52. It was against this background that the IAEA commenced its first on-site inspection campaign on 15 May 1991.

Implementation

53. Since the commencement of the first on-site inspection campaign, in May 1991, the IAEA has, with the assistance and co-operation of the United Nations Special Commission (UNSCOM) and supporting member States, carried out twenty-nine such campaigns involving more than 500 facility inspections, in which many facilities were inspected several times, utilising more that 5,000 person-days of technical staff and support staff resources (see attachment 4). In addition, the IAEA has carried out a series of five inspections aimed at the review and verification of Iraq's re-issued "Full, Final and Complete" declaration (FFCD) of its clandestine nuclear programme - required of Iraq resulting from the revelations following the departure from Iraq of the late Lt. Gen. Hussein Kamel Hassan Al Majid and issued in draft form in February 1996.

54. As a result of the IAEA's inspection activities, a technically coherent picture of Iraq's clandestine nuclear programme has evolved revealing a programme aimed at the production of an arsenal of nuclear weapons, based on implosion technology, which had involved:

- Acquisition of non-weapon-usable nuclear material through indigenous production and through overt and covert foreign procurement.

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- Research and development programmes into the full range of uranium enrichment technologies culminating in the industrialisation of EMIS and the demonstration of a proven prototype gas centrifuge.

- Development of metallurgical technologies necessary for the fabrication of the uranium components of a nuclear weapon.

- Research and development activities related to the production of plutonium, including laboratory-scale reprocessing of irradiated nuclear material and reactor design studies.

- Development of nuclear weapon designs and weaponisation technologies for implosion devices and the establishment of industrial-scale facilities for their further development and production.

- Research and development activities related to the integration of a nuclear weapon with a missile delivery system.

55. Understanding of the details of Iraq's clandestine nuclear programme has been severely hampered by Iraq's persistence in a policy of concealment and understatement of the programme's scope and achievements. The most extreme example of this policy was Iraq's initial endeavour to conceal the programme in its entirety by removing and concealing tell-tale equipment and materials from the sites involved. The stripping of EMIS equipment from Tuwaitha and Tarmiya and denying IAEA access to the concealment locations at Abu Grahib and Falluja typified this effort. Even after Iraq's revised declaration of 7 July 1991, issued after the Falluja confrontation, Iraq continued to deny the actual mission and achievements of the Al Atheer nuclear weapons development and production facility, as well as the actual location of the gas centrifuge development facility.

56. Iraq's revised declaration of 7 July 1991 included reference to its research and development activities involving the recovery of plutonium from the reprocessing of nuclear material irradiated in the IRT-5000 research reactor. Subsequent inspection confirmed that there had been three reprocessing campaigns, carried out in the hot cells of the radio-chemical laboratory at Tuwaitha, and that some five grams of plutonium had been recovered. This activity was complemented by project 182, which aimed at the design and indigenous construction of a 40 MW natural uranium/heavy water research reactor and would have provided the basis for a capability to produce and separate substantial amounts of weapon-usable plutonium.

57. Of immense assistance to the uncovering of Iraq's clandestine nuclear programme was the large cache of documentation obtained during the sixth and seventh on-site inspection campaigns, carried out between 22 September and 22 October 1991. These documents provided a comprehensive insight into that part of the programme which had been developed under the code name Petrochemical Project 3 (PC-3). Although, on 23 September, Iraq had forcibly removed the bulk of these documents from IAEA custody for a period of about six hours, during which time, according to Iraq's later statement, it had catalogued the reports and removed all documents relating to PC-3 Group 4 (weaponisation), the IAEA had been able to secure a number of documents which provided incontrovertible

evidence that the real mission of the Al Atheer facility was the development and production of nuclear weapons. Since August 1995, Iraq has provided to the IAEA a large amount of programme documentation, but it remains unclear whether all of the documents removed by the Iraqi counterpart on 23 September 1991, have been subsequently handed over to the IAEA.

58. Nothing related to the gas centrifuge programme was found in the documentation cache, even though Iraq claimed that the programme had been co-located with PC-3 at Tuwaitha. Iraq offered the explanation that the centrifuge programme had been separately managed and funded and that its records had been separately stored and, like all other programme records, were being destroyed in the time-frame of the IAEA-6 inspection campaign. Iraq also maintained that no political decision had been made to go ahead with the development of nuclear weapons and persisted with its claim that the actual mission of the Al Atheer facility was that of a materials study centre.

59. Despite Iraq's prevarication, the IAEA carried out a comprehensive campaign of destruction, removal and rendering harmless of the practical assets of Iraq's clandestine nuclear programme. This campaign involved the extensive destruction of buildings and equipment at the EMIS sites at Tuwaitha, Al Tarmiya and Al Sharqat, and at the nuclear weapons development and production sites at Al Atheer and Al Qa Qaa; of the laboratory-scale reprocessing facilities at Tuwaitha; and of gas centrifuge related materials, components and equipment. In total, more than 50,000 square metres of facility floor space were destroyed by explosives and more than 1,900 individual items and 600 tons of sensitive alloys, useful in a nuclear weapons programme or in uranium enrichment activities, were destroyed or rendered harmless (see attachment 3).

60. Those destruction and rendering harmless activities, which were essentially completed by November 1992, were complemented by the removal from Iraq of all known nuclear-weapon-usable nuclear material and the removal to the IAEA's Vienna headquarters of some specialised equipment. The removal of the nuclear-weapon-usable nuclear material was accomplished in two phases, with the unirradiated and lightly-irradiated material being removed in three consignments during the period November 1991 to June 1992, and the more complex task of removing the irradiated material being accomplished, in two consignments during the period December 1993 to February 1994.

61. In the autumn of 1992, work commenced to phase in ongoing monitoring and verification activities as typified by the commencement in September of that year of the baseline sampling for the now routine twice-yearly hydrological survey of Iraq's major watercourses.

62. On-site inspection activities and discussions with the counterpart continued to focus on gaining a better understanding of Iraq's achievements in weaponisation and in the development of gas centrifuge uranium enrichment technology. Many attempts were also made to persuade the counterpart to provide meaningful information on procurement and on foreign assistance to its centrifuge design achievements. Despite Iraq's many promises of co-operation, these matters remained at an impasse until, as a result of a series of high-level talks held during the period August 1993 to October 1993, Iraq finally

agreed to provide procurement information and, most notably, to identify the sources of foreign assistance to the centrifuge programme.

63. These revelations enabled the IAEA to confirm member State information on Iraqi procurement and to identify the source and procurement strategy for the consignment of 100 tonnes of maraging steel which had been destroyed by Iraq in April/May 1991 and further adulterated under IAEA supervision in November 1992. Of substantial importance was Iraq's explanation of its acquisition of gas centrifuge design information, including the identification of the foreign nationals involved.

64. Although progress was made in the verification of procurement transactions, little further advance was made in mapping the scope of Iraq's clandestine nuclear programme until September 1994, when, following up on member State information, the IAEA (inspection campaign IAEA-26), after a series of discussions and facility inspections, obtained an admission from Iraq that an exploratory programme to examine laser isotopic separation (LIS) technologies had been established in 1981. The programme, which had been assigned to the laser group within the Physics Department of the Iraqi Atomic Energy Commission (Tuwaitha), was stated to have continued, without success, until 1987, when it had been relegated to a "watching brief". The expert opinion within IAEA-26 was that Iraq's explanation of its LIS activities was plausible but surprise was expressed that Iraq had not undertaken the relatively simple step of vaporising uranium metal (see attachment 1, sect. 1.2.5).

65. In August 1994, concurrent with inspection campaign IAEA-26, the IAEA commenced its continuous presence in Iraq through the establishment of its Nuclear Monitoring Group (NMG).

66. In the aftermath of the August 1995 departure from Iraq of the late Lt. General Hussein Kamel, Iraq released additional information regarding its weaponisation and gas centrifuge enrichment programmes and revealed the existence of a plan in August 1990 to divert the safeguarded research reactor fuel to accelerate, through a "crash programme", Iraq's attainment of nuclear weapons. At the same time Iraq admitted that the actual mission of the Al Atheer facility had been the development and production of nuclear weapons, and confirmed that the Rashdiya site of the Engineering Design Centre had been the headquarters of the gas centrifuge enrichment programme since its establishment in 1987. The information released by Iraq included a large cache of documentation comprising PC-3 technical reports, engineering drawings, records of meetings and procurement correspondence, which was handed over to UNSCOM and later to the IAEA, at the Haider House farm - a property stated by Iraq as having belonged to the family of Hussein Kamel.

67. Two inspection campaigns (IAEA-28 and IAEA-29) were mounted, in September and October 1995, respectively, to review the information revealed by Iraq. In the course of these inspections it became evident that Iraq had made significantly more progress than previously declared in the development of the implosion package, largely through efforts at the Al Qa Qaa establishment; had accumulated more experience in uranium metallurgy than previously admitted; was, in January 1991, ready to commence the recovery of the highly enriched uranium (HEU) from the safeguarded research reactor fuel; and had begun work to

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accelerate the integration of the nuclear weapon with a missile delivery system. In the course of these inspections Iraq released further documentation, most notably an optical disc containing electronic copies of many documents related to the work of PC-3 Group 4 (weaponisation). Since these inspections Iraq has continued to provide additional documentation, some of which was provided spontaneously and some in response to IAEA questioning.

68. The re-examination of the scope and achievements of the gas centrifuge enrichment programme was also addressed during these inspection campaigns and further clarification was obtained with respect to the extent and nature of foreign assistance. The Iraqi counterpart withdrew earlier explanations it had devised to protect the sources of foreign assistance, and revealed that many drawings and specifications relating to centrifuge machines had been provided, some of which concerned advanced technology, multi-cylinder machines. It was also learned that Iraq had planned to build a third centrifuge facility at a location in south Taji which would have accommodated cascade halls of up to 1,000 machines and, which according to the Iraqi counterpart, would have been the site of a future commercial scale UF6 production facility.

69. Iraq's rapidly developing programme for the design, development, manufacture and operation of gas centrifuge machines was not, according to the Iraqi counterpart, matched by a similar high priority plan for the secure supply of production-scale amounts of UF_6 - the basic feed material. Iraq has declared its laboratory-scale UF_6 production capacity to have been more than adequate to support the ongoing development activities in 1990 and considered that there was no urgency to provide for large-scale production.

70. Since October 1995, the IAEA has been reviewing the Haider House farm cache to evaluate Iraq's statements and, on the basis of this and other activities, has removed from Iraq a number of single-purpose items and secured for eventual destruction or rendering harmless quantities of aluminium and maraging steel and other equipment and materials.

The scope and status of Iraq's clandestine nuclear programme

71. The results of the IAEA's on-site inspection of Iraq's nuclear capabilities have, over time, produced a picture of a very well-funded programme aimed at the indigenous development and exploitation of technologies for the production of weapon-usable nuclear material and the development and production of nuclear weapons, with a target date of 1991 for the first weapon.

72. The programme, which is described in greater detail in attachment 1 to the present report, comprised:

- Indigenous production and overt and covert procurement of natural uranium compounds. In this regard:

  All known indigenous facilities capable of production of amounts of uranium compounds useful to a reconstituted nuclear programme have been destroyed along with their principal equipment;

  All known procured uranium compounds are in the custody of the IAEA;

All known practically recoverable amounts of indigenously produced uranium compounds are in the custody of the IAEA.

- Industrial-scale facilities for the production of pure uranium compounds suitable for fuel fabrication or isotopic enrichment. In this regard:

  All known facilities for the industrial-scale production of pure uranium compounds suitable for fuel fabrication or isotopic enrichment have been destroyed, along with their principal equipment.

- Research and development of the full range of enrichment technologies culminating in the industrial-scale exploitation of EMIS and substantial progress towards similar exploitation of gas centrifuge enrichment technology. In this regard:

  All known single-use equipment used in the research and development of enrichment technologies has been destroyed, removed or rendered harmless;

  All known dual-use equipment used in the research and development of enrichment technologies is subjected to ongoing monitoring and verification;

  All known facilities and equipment for the enrichment of uranium through EMIS technologies have been destroyed along with their principal equipment.

- Design and feasibility studies for an indigenous plutonium production reactor. In this regard:

  IAEA inspections have revealed no indications that Iraq's plans for an indigenous plutonium production reactor proceeded beyond a feasibility study.

- Research and development of irradiated fuel reprocessing technology. In this regard:

  The facility used for research and development of irradiated fuel reprocessing technology was destroyed in the bombardment of Tuwaitha and the process-dedicated equipment has been destroyed or rendered harmless.

- Research and development of weaponisation capabilities for implosion-based nuclear weapons. In this regard:

  The principal buildings of the Al Atheer nuclear weapons development and production plant have been destroyed and all known purpose-specific equipment has been destroyed, removed or rendered harmless.

- A "crash programme" aimed at diverting safeguarded research reactor fuel and recovering the HEU for use in a nuclear weapon. In this regard:

  The entire inventory of research reactor fuel was verified and accounted for by the IAEA and maintained under IAEA custody until it was removed from Iraq.

Summary

73. The Security Council, in resolution 687 (1991), envisaged that, within fifteen days of adoption of the resolution, Iraq would submit to the Director General of the IAEA a declaration of the locations, amounts and types of all items specified in paragraph 12 of the resolution. It further envisaged that the IAEA would carry out immediate on-site inspections of Iraq's nuclear capabilities based on Iraq's declarations and the designation of any additional locations by the Special Commission, and that the Agency would develop a plan for submission to the Security Council within forty-five days calling for the destruction, removal or rendering harmless, as appropriate, of all items listed in paragraph 12 of the resolution. The IAEA was expected to commence to carry out that plan within forty-five days after its approval by the Security Council.

74. It was not possible for the IAEA to follow such a timetable, primarily because Iraq chose to follow a course of denial, concealment and obstruction, rather than meeting its obligation to provide, at the outset, the declaration foreseen by resolution 687. The initial declarations provided by Iraq were totally inadequate and the IAEA's access to designated inspection sites was obstructed. Following the visit to Iraq in July 1991 of a United Nations/IAEA high-level delegation and the personal intervention of the Secretary-General, Iraq modified its initial approach and provided a considerably expanded, though still incomplete declaration. However, Iraq continued to conceal and deny aspects of its weaponisation and centrifuge enrichment activities until the revelations which followed the August 1995 departure from Iraq of the late Lt. Gen. Hussein Kamel. Since that time, Iraq has been more forthcoming in providing information, although it still continues to limit the scope of information provided in response to IAEA questioning in an effort to understate the capabilities developed within the clandestine nuclear programme.

75. In connection with its technical team visits, since May 1997, the IAEA has received clarification of many matters raised with the Iraqi counterpart. While containing little new information, Iraq's written statements provided a helpful collation of previously reviewed information. In one critical area, Iraq was able to provide copies of correspondence which, if genuine, provide strong corroboration of Iraq's description of the status, as of the end of 1990, of its work to develop explosive lenses. However, the Iraqi counterpart: has not provided a comprehensive written statement of the membership, terms of reference and duration of authority of the Governmental Committee charged, *inter alia*, to "reduce the effect of NPT violation to the minimum"; has stated that it has no further information regarding external assistance to its clandestine nuclear programme; has declared itself unable to describe the motives behind the actions ascribed to the late Lt. Gen. Hussein Kamel which resulted in the concealment of the cache of documentation, material and equipment "discovered" at the Haider House farm; has declined to include, in its FFCD a summary of the practical and theoretical achievements of Iraq's clandestine nuclear programme; and has yet to provide the promised written description of its post-war procurement system.

76. Iraq's lack of co-operation has required the IAEA to follow a protracted and painstaking process involving on-site inspections, collection and analysis of procurement information and follow-up of other information provided by member

States. The results of the IAEA's investigation have over many years yielded a technically coherent picture of Iraq's clandestine nuclear programme.

77. Although certain documentary evidence is missing and some gaps in knowledge remain, the following can be stated with regard to Iraq's clandestine programme:

- There are no indications to suggest that Iraq was successful in its attempt to produce nuclear weapons. Iraq's explanation of its progress towards the finalisation of a workable design for its nuclear weapons is considered to be consistent with the resources and time scale indicated by the available programme documentation. However, no documentation or other evidence is available to show the actual status of the weapon design when the programme was interrupted.

- Iraq was at, or close to, the threshold of success in such areas as the production of HEU through the EMIS process, the production and pilot cascading of single-cylinder sub-critical gas centrifuge machines, and the fabrication of the explosive package for a nuclear weapon.

- There are no indications to suggest that Iraq had produced more that a few grams of weapon-usable nuclear material (HEU or separated plutonium) through its indigenous processes, all of which has been removed from Iraq.

- There are no indications that Iraq otherwise acquired weapon-usable nuclear material.

- All of the safeguarded research reactor fuel, including the HEU fuel that Iraq had planned to divert to its "crash programme", was verified and fully accounted for by the IAEA and removed from Iraq.

- There are no indications that there remains in Iraq any physical capability for the production of amounts of weapon-usable nuclear material of any practical significance.

78. Iraq's description of its development of the single-cylinder sub-critical gas centrifuge is considered to be consistent with the resources and time scale indicated by the available documentation and the status of the related facilities. Although little documentation is available, it is clear that Iraq had intentions to exploit the information in its possession regarding multi-cylinder, super-critical centrifuge machines. It will be necessary to gain access to Iraq's foreign source of information in order to have the opportunity to verify Iraq's explanation that only limited exploratory design-work had been undertaken.

79. There are no indications of significant discrepancies between the technically coherent picture which has evolved of Iraq's past programme and the information contained in Iraq's FFCD-F issued on 7 September 1996, as supplemented by the written revisions and additions provided by Iraq since that time. However, taking into account the possibility, albeit remote, of undetected duplicate facilities or the existence of anomalous activities or facilities outside this technically coherent picture, no absolute assurances can be given with regard to the completeness of Iraq's FFCD. Some uncertainty is

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inevitable in any country-wide technical verification process which aims to prove the absence of readily concealable objects or activities. The extent to which such uncertainty is acceptable is a policy judgement.

80. Most of the IAEA activities involving the destruction, removal and rendering harmless of the components of Iraq's nuclear weapons programme which to date have been revealed and destroyed, were completed by the end of 1992 (see attachment 3). Since that time, only a relatively small number of items of proscribed equipment and materials have been identified and disposed of, most of which were handed over to the IAEA by Iraq since the events of August 1995. While no indications of the presence of further proscribed equipment or materials in Iraq have been found, the IAEA, despite its extensive inspection activities, cannot, for the reasons described in the previous paragraph, provide absolute assurance of the absence of readily concealable items, such as components of centrifuge machines or copies of weapon-related documentation.

81. The IAEA's ongoing monitoring and verification (OMV) plan was phased-in during the period from November 1992 to August 1994, at which time it was considered to be operational. Taking into account the extensive technological expertise developed by Iraq in the course of its clandestine nuclear programme, the OMV plan is predicated on the assumption that Iraq retains the capability to exploit, for nuclear weapons purposes, any materials or technology to which it may gain access in the future.

82. Implementation of the OMV plan has not resulted in the detection of any indications of ongoing proscribed activities or the presence in Iraq of proscribed equipment or materials apart from the items referred to in paragraph 80. It should be recognised, however, that OMV measures cannot guarantee detection of readily concealable or disguisable proscribed activities, such as computer-based weaponisation studies or small-scale centrifuge cascade development. Iraq's direct acquisition of weapon-usable nuclear material would also present a severe technical challenge to the OMV measures and great reliance must be placed on international controls.

83. As indicated in the foregoing, the IAEA's activities regarding the investigation of Iraq's clandestine nuclear programme have reached a point of diminishing returns and the IAEA is focusing most of its resources on the implementation and technical strengthening of its plan for the ongoing monitoring and verification of Iraq's compliance with its obligations under the relevant Security Council resolutions. The IAEA is not "closing the books" on its investigation of Iraq's clandestine nuclear programme and will continue to exercise its right to investigate any aspect of Iraq's clandestine nuclear programme, in particular, through the follow-up of any new information developed by the IAEA or provided by member States and assessed by the IAEA to warrant further investigation, and to destroy, remove or render harmless any proscribed items discovered through such investigations.

Attachments

Attachment 1	The components of Iraq's clandestine nuclear programme
Attachment 2	Chronology of major events
Attachment 3	Destruction, removal and rendering harmless
3.1	Main equipment and materials used in Iraq's clandestine nuclear programme which were destroyed or rendered harmless under IAEA supervision
3.2	Main equipment and materials used in Iraq's clandestine nuclear programme removed by IAEA
3.3	Main buildings of the sites directly involved in Iraq's clandestine nuclear programme destroyed under IAEA supervision
3.4	Main buildings of the sites directly involved in Iraq's clandestine nuclear programme destroyed in the aerial bombardment (January-February 1991)
3.5	Uranium fuel removed from Iraq under IAEA supervision
3.6	Plutonium removed from Iraq under IAEA supervision
Attachment 4	Summary of IAEA inspection campaigns

Attachment 1. The components of Iraq's clandestine nuclear programme

1. The acquisition of weapons-usable nuclear material

1.1 Procurement and indigenous production of uranium compounds
    1.1.1 Material declared and subject to IAEA safeguards
    1.1.2 Procurement of yellow cake and uranium dioxide
    1.1.3 The Al Qaim uranium recovery facility
    1.1.4 The Al Jesira uranium conversion facility
    1.1.5 Uranium pilot plant development at Tuwaitha
    1.1.6 Summary
    Table 1.1 Material balance – Tuwaitha uranium projects

1.2. Development of indigenous uranium enrichment capabilities
    1.2.1. Electro-magnetic isotope separation (EMIS)
    1.2.2 Gaseous diffusion uranium enrichment
    1.2.3 Gas centrifuge uranium enrichment
    1.2.4 Chemical and ion-exchange uranium enrichment
    1.2.5 Laser isotopic separation
    1.2.6 Summary

1.3 The intended diversion of research reactor fuel
    1.3.1 The "crash programme"
    1.3.2 The recovery of HEU – Project 601/603
    1.3.3 The further enrichment of the HEU – Project 521C
    1.3.4 The conversion to metal of HEU – Project 602/602B
    1.3.5 Summary
    Table 1.3 Iraq's research reactor fuel inventory as verified by the IAEA on 19/20 November 1990

1.4 The production and separation of plutonium
    1.4.1 The indigenous reactor – Project 182
    1.4.2 The use of the IRT 5000 reactor
    1.4.3 The separation of plutonium
    1.4.4 Summary

2. Weaponisation
    2.1 Background
    2.2 Facilities
    2.3 Research and development
    2.4 Missile delivery system
    2.5 Programme documentation
    2.6 Summary

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1. The acquisition of weapons-usable nuclear material

1.1. Procurement and production of uranium compounds

1.1.1 Material declared and subject to IAEA Safeguards

a. Low enriched uranium

In 1982 Iraq imported from Italy 1,767 kg of uranium enriched to 2.6% in U-235 in the form of UO_2 powder. The material has been verified and fully accounted for and remains in Iraq, under the control of the IAEA, at Location C (a storage complex close to Tuwaitha), in the same form as it was received.

b. Natural uranium

In 1979, Iraq imported from Italy 4,006 kg of natural uranium as UO_2 powder and 508 kg uranium as UO_2 in the form of pressed fuel pellets. The UO_2 powder and the pellets were used in the Experimental Research Laboratory for Fuel Fabrication (ERLFF) for research and development activities. Of the 4,514 kg uranium received, 4,323 kg uranium have been accounted for, leaving 191 kg not accounted for. This amount is less than the declared accumulation of "material unaccounted for" and measured discards over the period 1982 to 1990 and may be considered to be consistent with the nature of the facility operation. The balance of this material has been verified and fully accounted for and remains in Iraq, under the control of the IAEA, at Location C.

c. Depleted uranium

In 1979, Iraq imported from Italy, 6,005 kg of depleted uranium as UO_2 powder. The material has been verified and fully accounted for and remains in Iraq, under the control of the IAEA, at Location C, in the same form as it was received.

d. Highly enriched uranium

Iraq's inventory of research reactor fuel which was imported from Russia and France contained almost 50 kg of highly enriched uranium, based on pre-irradiation values. All of Iraq's inventory of research reactor fuel, as listed in Table 1.3, was fully accounted for and removed from Iraq – the last consignment having been shipped in February 1994.

1.1.2 Procurement of yellowcake and uranium dioxide

In the period 1979 through 1982, Iraq procured yellowcake from both Portugal and Niger and uranium dioxide from Brazil. At that time, neither Niger nor Brazil were party to the NPT, nor had either concluded a comprehensive safeguards agreement, which would have required notification to the Agency of the transfers of such material to Iraq. Portugal, a party to the NPT, but without a comprehensive safeguards agreement at that time, notified the Agency of the transfers to Iraq."

The yellowcake procured from Portugal was supplied in two batches. Batch 1, received on 20 June 1980, consisted of 429 drums containing 138,098 kg of yellowcake and batch two, received as three consignments over the period from 17 May 1982 through 20 June 1982, consisted of 487 drums containing 148,348 kg yellow cake. By letters dated 6 August 1981, 1 June 1982 and 21 July 1982, Iraq notified the IAEA of the receipt of this material, which confirmed the complementary notifications received from Portugal at the time of shipment. Iraq's entire holding of the material of this origin was verified against comprehensive packing lists provided to the IAEA by the Iraqi counterpart, detailing the original production lot number together with weight data for each drum. Verification measures involved weighing, non-destructive assay and sampling and analysis from which it was concluded that all of the yellowcake received from Portugal was fully accounted for and remained intact, as shipped, except for the loss of about 40 kg from a drum damaged during Iraq's salvaging/concealment activities in 1991. This material remains in Iraq, under the control of the IAEA, at Location C, in the same form as it was received.

The yellowcake procured from Niger was also shipped in two batches. Batch one, received on 8 February 1981, consisted of 432 drums containing 137,435 kg of yellowcake and batch two, received on 18 March 1982, consisted of 426 drums containing 139,409 kg yellowcake. By letter dated 6 August 1981 Iraq notified the IAEA of the receipt of the first consignment but did not provide notification of receipt of the second consignment. Iraq's entire holding of material of this origin was verified against comprehensive packing lists for both batches, provided to the IAEA by the Iraqi counterpart, detailing the original production lot number together with weight data for each drum. Verification measures involved weighing, non-destructive assay and sampling and analysis from which it was concluded that all of the yellowcake received from Niger was fully accounted for. This material remains in Iraq, under the control of the IAEA, at Location C, in the same form as it was received.

Iraq did not report to the IAEA the 1981/1982 import of uranium dioxide (UO_2) from Brazil and its existence in Iraq was only recognised at the time of Iraq's revised declaration of 7 July 1991. Verification and accountancy of the UO_2 procured from Brazil was complicated by the fact that Iraq was unable to provide adequate shipping documents for all of the material and declared that it had used some 4,422 kg out of its estimated total receipts of 27,000 kg UO_2. Iraq declared that there had been two receipts of UO_2 from Brazil, the first in August 1981, consisting of 7,914 kg UO_2 in 120 drums, and a second receipt in the first half of 1982 consisting of 128 drums containing from 17,300 to 19,200 kg UO_2. Iraq claimed not to know how much material was in the second shipment asserting that it had arrived without shipping documents and that the material had not been weighed in Iraq. The only available documentation for the two shipments was a list of weights for the first shipment and a list of analytical results for the second. Verification activities carried out during

IAEA-12 showed the amount on inventory to be considerably less than declared - thus putting into question the reported consumption. Furthermore, the varied and unusual physical forms of the UO_2 raised doubts as to its origin.

An extensive verification effort was subsequently undertaken involving weighing, non-destructive assay, sampling and analysis and microscopic examination of the physical form and properties of a comprehensive series of samples of the material. In this way the range of powders and granules comprising the Brazilian UO_2 material were characterised and shown to be distinctly different from the material overtly imported or indigenously produced.

The task was finally completed in July 1994 when, with the co-operation of the Government of Brazil, it was possible to confirm the origin of the UO_2 on the basis of the chemical and physical characteristics determined by the IAEA. At this time it was also possible to gain confirmation of the amount of material shipped to Iraq. These data enabled the IAEA to verify and balance Iraq's declared usage against the material remaining on inventory. Of the 24,260 kg UO_2 received by Iraq from Brazil, 3,600 kg was used to produce UCl_4, UF4, and uranium metal - the rest has been verified and remains in Iraq, under IAEA control, at Location C.

1.1.3 The Al Qaim uranium recovery facility

The phosphate rock deposits of western Iraq contain uranium in the range of 50 - 80 ppm. A large deposit at Akashat is mined to supply a phosphate fertiliser plant at Al Qaim, some 150 km distant. During the period 1982 to 1984 a plant (Unit 340) for the extraction of uranium from the process phosphoric acid was constructed and commissioned. Operating at design capacity the plant should have produced 103 tonnes of uranium per year - equivalent to 146 tons of yellowcake – assuming 317 operating-days and processing 3,600 m^3 per day of phosphoric acid containing 75 ppm uranium at a recovery efficiency of 93%. Over its six years of declared operation the plant should have produced about 600 tonnes of uranium contained in nearly 900 tonnes of yellowcake. However, Iraq declared a production of only 109 tonnes of uranium in 168 tonnes of yellowcake, i.e., less than 20% of the design capacity of the plant.

The investigation of this apparent inconsistency was greatly facilitated by the presence of a set of operating records – daily production reports – covering the period from 1986 through 1990 and containing day-by-day data on input and output phosphoric acid flows and their respective uranium contents, the relative levels of two key chemical tanks and the number of drums (including drum serial numbers) of yellowcake produced.

An extensive evaluation of these data was undertaken to assess the consistency of the daily operating data with the yellowcake production. On the basis of sampling at the Akashat mine, a relationship was derived between the uranium and phosphorous pentoxide content of the ore, which enabled the calculation of uranium in the input acid stream. On this basis it was possible to derive a theoretical estimate of the plant production which was in very good agreement with the declared production.

This analysis also showed that the poor performance of the plant was due to the low assay of the feed acid (~ 60% of design value), the inability of the acid plant to meet the design flow-rate of 3,600 m^3/day (~ 50% of design flow-rate), failure to sustain the 93% design recovery efficiency (actual values typically 78%) and the fact that the plant on average operated only 214 days per year as opposed to the design operation of 317 days per year.

1.1.4 The Al Jesira uranium conversion facility

The Al Jesira uranium dioxide and uranium tetrachloride (UCl_4) production facility, located west of Mosul in northern Iraq combined a UO_2 plant of 185 MT/year design capacity, designated as Project 212 and code named the "Wax Plant", and a UCl_4 plant of 105 MT/year design capacity, designated Project 244. Both plants sustained considerable damage through aerial bombardment and were thus rendered inoperable in January 1991. Inspection of the facility was complicated by actions taken by Iraq to conceal the true function of the facility which involved the removal of all nuclear material from the facility, the transfer of 2,500 cubic metres of uranium bearing liquid waste to a petroleum storage tank, near Mosul, some 30 km distant from Al Jesira, and the removal and burial of uranium contaminated plant components and waste disposal system pipework at Al Adaya.

a. UO_2 production

The UO_2 production plant was based on designs provided by a Brazilian company. The plant, which was constructed by Iraq in the period July 1985 to July 1989, was based on the well-proven technology involving the dissolution of the input yellowcake in nitric acid followed by multi-stage solvent extraction, ammonium diuranate precipitation, its filtration and calcination to uranium trioxide, from which the UO_2 was produced through hydrogen reduction. Design production capacity was 23.7 kg UO_2/hr. The plant began its commissioning phase of operations on 5 July 1989, which continued through to the end of January 1990. This phase was beset with difficulties and the plant operating records show that only 8,879 kg UO_2 was produced. The plant went into routine operation in February 1990 and, apart from being shut down during the month of April of that year, continued to operate until 2 December 1990, by which time all of the available Al Qaim yellowcake had been processed. It was necessary to prepare the plant to process either Niger or Portuguese yellowcake and, during December and early January 1991, there was sporadic operation to clean up waste and scrap and to prepare the process for a new feed material of different chemical form.

The Al Jesira UO_2 plant produced 420 drums containing 99,457 kg UO_2 (86,607 kg uranium). Of these 420 drums, five were used for UCl_4 production at Al Jesira, four were used for UCl_4 production in the Chemical Engineering laboratory (Tuwaitha

Building 85), and two were used for uranium metal production in the Experimental Research Laboratory for Fuel Fabrication (ERLFF - Tuwaitha Bldg 73). The remaining 409 drums are currently stored under IAEA control at Location C.

Al Qaim yellowcake containing 98,512 kg uranium was received at Al Jesira and was converted into UO_2 containing 86,607 kg uranium, resulting in a difference of 11,905 kg uranium. This difference has been investigated in detail and it is estimated that 10,140 kg uranium can be accepted to be present in waste products and damaged plant components, leaving 1,765 kg uranium unaccounted for. This figure is deliberately conservative and could be reduced if greater allowance were to be made for losses resulting from accidental dispersal through Iraq's concealment activities, losses to solvent extraction fluids and losses through dispersal resulting from the aerial bombardment.

b. UCl_4 production

The UCl_4 production plant, Project 244, was constructed at the Al Jesira site based on design and operating experience gained from the UCl_4 pilot plant (Project 242) built and operated in Building 85 at Tuwaitha. Construction of the Al Jesira plant started in February 1988 and operations commenced on 1 February 1990. The plant consisted of two parallel production lines with a combined capacity of 105 MT/year of UCl_4. Only one line was operational.

The UCl_4 plant operation was limited to a period of 72 hours during the month of February 1990, when it was used to produce a total of 1,200 kg UCl_4, containing 780 kg uranium from an input feed of 1,036 kg UO_2 containing 901 kg uranium and generated waste containing 121 kg uranium. Following this brief period of operation the plant was shutdown for maintenance and repairs and was never again brought back into operation. All of the UCl_4 produced at Al Jesira is stored, under IAEA control, at Location C.

Although it seems inconsistent that the plant would be shut down after only a few days operation, it should be recalled that the plant had been commissioned well ahead of the need for its contribution to the supply of UCl_4 for the EMIS programme. The commissioning of separators at the Tarmiya EMIS facility began in February 1990 and only eight separators were in partial service before operations were interrupted by the aerial bombardment in January 1991. Even in full operation the Tarmiya plant would have required an annual feed of no more than 3,000 kg UCl_4, an amount well within the production capacity of Project 242 (Tuwaitha Building 85).

1.1.5 Uranium pilot plant development at Tuwaitha

The principal production and use of uranium compounds at Tuwaitha took place in three locations:

- Chemical laboratories (Building 15B) which processed Brazilian-origin UO_2 to produce UF_4, uranium metal and UF_6.

- Experimental Research Laboratory for Fuel Fabrication (ERLFF - Building 73) which processed Brazilian origin UO_2, Al Jesira origin UO_2 and Al Qaim yellowcake to produce UO_2, U_3O_8, UO_3, UO_4, UF_4 and uranium metal.

- Chemical Engineering Research laboratories (Building 85) which processed Brazilian origin UO_2 and Al Jesira origin UO_2 to produce UCl_4.

Of particular note is the development of Iraq's capabilities with respect to the production and casting of uranium metal, which originated in Tuwaitha in the middle of 1986. The first phase of this work, which continued through March 1987 was carried out in Building 15 and involved some 30 experiments involving the magnothermic reduction of UF_4. The experiments resulted in the production of discs of uranium metal of eight centimetre diameter, having individual weights in the range 600 to 900 grams – 19 such discs remain on inventory at Location C. The experimental work was discontinued in Building 15 and work was not resumed until the beginning of 1988 when facilities in Building 73 were then utilised for the task. The early work in this second phase concentrated on the development of methods to improve the purity of the UF_4 feed material and it was not until November 1988 that uranium metal production recommenced. The metal produced in this phase was again in disc form but somewhat thicker – termed "derbies" to distinguish them from the previously produced "discs" – and typically weighed 1.3 kg. Phase three involved continued efforts to improve the purity of the UF_4 feed material and a change in the physical form of the produced uranium metal to a solid cylinder of about 5cm diameter and similar length with a typical weight of 1.5 kg.

By late-1989, this research and development had enabled Iraq to establish its capability to produce uranium metal of high purity with relatively small process losses. On the basis of this capability a larger scale plant was designed and constructed in Building 64 at Tuwaitha with the capacity to produce 20 kg of uranium metal per day. The plant was still under commissioning in January 1991 when Building 64 was heavily damaged in the bombardment of Tuwaitha. Despite the severe damage to the building, much of the equipment, which was general purpose in nature, was salvaged and is currently located at the Al Zahf Al Kabir metallurgical facility in the Taji area, where it is subject to ongoing monitoring and verification.

Some 1,150 kg of natural uranium metal was made in the period 1986 to January 1991, of which 1,000 kg remains in Iraq under IAEA control. About 150 kg was used in a series of metal purification and melting and casting experiments at Tuwaitha and Al Atheer. The most interesting pieces cast were a 5 cm diameter sphere and a small number of 5 cm diameter hemispheres. Except for 10 small uranium bullets and 9 cast rods, all castings and machined uranium pieces were unilaterally destroyed by Iraq, by dissolution in HNO_3 as a concealment measure. Examination of the bullets and bars indicates only rudimentary melting and casting capabilities but, as claimed

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by Iraq, and supported by PC-3 programme documentation, Iraq expected that considerable improvements would be achieved through utilisation of the more advanced equipment that was soon to be installed at Al Atheer. Much of that equipment was blocked by the export embargo imposed by Security Council resolution 661 (6 August 1990) and all key equipment that was installed at Al Atheer was subsequently destroyed under IAEA supervision.

Iraq's exploration of UF_4 and UF_6 production technology spanned the period 1981-1985 and, in 1986, led to the design of Project 206. This project was based on a fluidised bed reactor using anhydrous hydrofluoric acid to produce 2 kg/day of either UF_4 or UF_6. Before construction was completed, Project 206 was modified to produce 1-2 kg UF_4/batch and was renamed Project 231. However, according to the Iraqi counterpart, the modified equipment was never operated and attention was focused on rotary kiln technology.

Project 226, based on rotary kiln was technology, was constructed and commenced operation in mid 1986. This project used UO_2 of Brazilian origin as the feed material which was reacted with Freon 12 as the fluorinating agent, to produce UF_4. Project 226 was operated intermittently until 1991 and produced some 250 kg of UF_4. A small quantity of the UF_4 produced was used in 1987 to make uranium metal but the stated purpose of Project 226 was to provide a secure supply of UF_4 for eventual conversion to UF_6 to satisfy the needs of the gas centrifuge development programme. In the event, the material was not required and remains on inventory in Location C.

The lack of success with Project 206 also prompted consideration of the utility of batch processes using boat type reactors and small-scale experiments were carried out in 1985-1986 using both Fluorox as the fluorinating agent as well as direct fluoridation using fluorine gas. On the basis of this work, the direct fluorination method was selected for further development and a larger laboratory-scale boat type reactor unit, with a capacity of 50g UF_6 per batch, was constructed in 1986. This unit operated in Building 15B at Tuwaitha until mid-1987 when it was transferred to Rashdiya. The unit was replicated at Rashdiya and the two units constituted Project 234.

According to the Iraqi counterpart the amount of UF_6 produced by the unit operating at Tuwaitha was 3-4 kg and by both units operating at Rashdiya was about 4 kg. In 1988 a third unit (Project 235) was constructed at Rashdiya, based on Project 234 designs, and this unit is reported to have been used to produce a further 500 grams UF_6. Several other Projects for UF_6 production and purification are documented by the Iraqi counterpart, including Projects 230, 232, 233, 236, 237, 238 and 238A, but were declared not to have proceeded beyond the design stage.

The total recorded production of UF_6 is about 8 kg which, according to the Iraqi counterpart was hydrolysed to liquid waste except for 500 grams which is contained in a standard 1S cylinder. The hydrolysed waste and the remaining 500 grams UF_6 are on inventory in Location C.

According to the Iraqi counterpart Projects 234 and 235 provided adequate supplies of UF_6 to support the development work of the centrifuge programme. The counterpart also declared its confidence in its capability to exploit flame reactor technology, which was the basis of Project 236, to provide sufficient UF_6 to support the pre-production development phase. This expressed confidence was based on their declared acquisition of an assembly drawing of a 1970s design flame reactor.

Research and development work on UCl_4 production and purification at Tuwaitha is well recorded in IAEC/PC-3 documentation. Initial experiments commenced in 1982 in Buildings 9 and 15 and later, circa 1987, were transferred to Building 85, the Chemical Engineering Research Laboratories where activities continued until January 1991. Fifteen laboratory-scale research projects and pilot-scale production and purification projects were implemented during the nine years period. Many different feed materials, including, UO_2, UO_3, U_3O_8 and $UO_4{:}2H_2O$ were tried as were different reaction techniques such as fluid bed, static bed (boat type) and rotary reactors with liquid, vapour and gas phase chlorination.

The extensive experimentation culminated in the design and construction of a pilot scale production unit, Project 242, in Building 85, which used UO_2 as the feed material and gas phase chlorination. Project 242 which had a production capacity of 20-40 kg UCl_4 per day commenced operation in 1988 and continued, on a campaign basis, until the end of 1990. During this period some 5,000 kg UCl_4 was produced using Brazilian UO_2 and Al Jesira UO_2 as feed material. Project 242 was very successful and the chemical and operating experience so gained was used to design the industrial scale UCl_4 facility at Al Jesira.

Three projects, 241B, 245 and 244 were implemented from 1987 to 1990 to establish the capability to meet the purity requirements for EMIS feed material. These projects which were all based on sublimation were used to purify some 1,100 kg of UCl_4.

The nuclear material balance for these Tuwaitha locations (Table 1.1) shows a total receipt of 14,789 kg uranium of which 13,117 kg uranium has been verified and remains on inventory at Location C. The resultant inventory difference or "material unaccounted for" (MUF) is 1,672 kg uranium which represents 11.3 % of the total receipts. Some components of this MUF comprise strata which are physically present but difficult to verify, with any certainty, such as the Building 73 waste, plant hold-up, uranium losses to metal slag and others for which Iraq has provided a plausible explanation backed up by documentation, such as the hydrolysis of UF_6 and the dissolution of uranium metal. Conservative assessment of these components would reduce the MUF to 1,086 kg uranium or 7.3 % of the receipts. Given that some large inventory strata are inhomogeneous and thus potentially subject to large sampling errors, and accepting that the loss of some material, due to the bombardment and Iraq's salvage and concealment activities, cannot be discounted, the MUF value is not considered to be unreasonable.

1.1.6 Summary

1. Iraq's failure to provide complete notification to the IAEA of its importation of UO_2 (from Brazil) and yellowcake (from Niger) was in contravention of its safeguards agreement with the IAEA

2. None of the imported yellowcake had been used by Iraq and was fully accounted for through IAEA safeguards verification measures. This material remains under IAEA control at Location C and is routinely verified by the IAEA.

3. An amount of 3,600 kg of the natural uranium dioxide imported from Brazil was used for the production of uranium tetrachloride, uranium tetrafluoride, uranium hexafluoride and uranium metal and has been accounted for in those converted forms. The remainder of the UO_2 material of this origin has been unambiguously identified and fully accounted for. This material remains under IAEA control at Location C and is routinely verified by the IAEA.

4. As a result of its extensive audit, the IAEA is satisfied that Iraq's declared production of yellowcake at the Al Qaim facility, although well below the full design capacity of the plant, is consistent with the plant's mode of operation and is in good agreement with the plant operating records.

5. Taking into account the losses due to plant damage resulting from the bombardment and measures taken by Iraq to attempt to conceal the function of the plants, the amounts of uranium dioxide and uranium tetrachloride declared by Iraq to have been produced by the Al Jesira facilities are consistent with the plant input.

6. Again, taking into account the losses due to building damage resulting from the bombardment and measures taken by Iraq to attempt to conceal the function of the buildings, the amounts of uranium compounds and uranium metal declared by Iraq to have been produced at Tuwaitha are consistent with the amounts of feed material consumed.

7. The total amount of material unaccounted for, potentially arising from normal process losses taken together with the circumstantial losses referred to above, is determined to be just less than 3,000 kg natural uranium which is equivalent to 1.5 % of the non-static inventory.

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Table 1.1 Material balance – Tuwaitha uranium projects

Receipts into Tuwaitha uranium projects

Material origin	Compound type	Compound kg	Uranium kg
Brazilian	UO_2	3,600	3,150
Al Jesira	UO_2	2,504	2,180
Al Qaim	yellowcake	14,072	9,459
Total			14,789

Verified accumulated inventory

	UO_2		2,186
	UO_3		3,188
	UO_4		3,667
	UCl_4		1,917
	uranium metal		1,023
	UF_4		226
	ADU		598
	Miscellaneous		330
Total			13,117

Material unaccounted for (MUF)	1,672

Unverified components of MUF

	Hydrolysed UF6		7
	Waste – Building 73		206
	Dissolved uranium metal		150
	Uranium metal slag		60
	Plant hold-up		163
Total			586

Adjusted material unaccounted for	1086

Iraq's former holdings of research reactor fuel are listed in Table 3.1.

1.2. Development of indigenous uranium enrichment capabilities

As stated in the FFCD, Iraq's strategy for the acquisition of weapons-usable nuclear material, established at the end of 1981, was to use electro-magnetic isotope separation (EMIS) as the primary technology. The strategy foresaw the development of industrial-scale plants with production capacities of 15 kg/year of highly enriched uranium (HEU - 93%), based initially on natural uranium feed. Gaseous diffusion was chosen as a subsidiary technology with the declared objective of building a plant to produce 5 tonnes/year of low enriched uranium (LEU) containing 4% U-235 to be used as the feed material for the EMIS plants. Assuming that the EMIS plants could have been optimised to use LEU feed material, the combination of the two technologies could have more than tripled the capacity of each EMIS plant.

Other technologies such as gas centrifuge enrichment and laser isotopic separation (LIS) were not included in the initial strategy because of their greater technical complexity and dependency on equipment subject to export controls. Nonetheless, LIS and chemical and ion-exchange uranium enrichment processes were explored, although, according to the Iraqi counterpart, only centrifuge technology was taken beyond laboratory-scale exploitation.

In 1987, faced with what Iraq considered to be overwhelming difficulties in the further development of gaseous diffusion technology, reduced priority was given to this programme and the released resources were assigned to the development of gas centrifuge enrichment.

1.2.1 Electro-magnetic isotope separation (EMIS)

According to the Iraqi counterpart and substantiated by PC-3 documentation, the EMIS development programme was organised into three phases with the first phase concentrating on research and development activities using "R40" magnet/separation chambers. These units which were designed to have ion-beam paths of radius 40 centimetres, were 1:2.5 scale versions of the anticipated production-scale units. Phase one was established in Tuwaitha and continued over the period 1982 through 1987. It involved the construction and operation of an electromagnet (Project 101) and two different magnet/separator systems (Projects 102 and 103) all of which were in operation in Building 85 from the beginning of 1985.

The second phase, which overlapped phase one, commenced in 1983 and reached an experimental stage in 1987. Phase two was devoted to development of R50 and R100 pre-production-scale units (Project 104), as well as 1:5 scale model units (Project 105) which were used to investigate multi-magnet series operation as an analytical tool for the production phase configuration. Starting from 1985, a total of one R50 and three R100 magnet/separator systems were built and installed in Building 80 at Tuwaitha and were operated until 1991. According to programme progress reports obtained by IAEA-6, none of these separators achieved more than

20% of their design capacity. This performance is in keeping with Iraq's declaration that the total production of enriched uranium from the development separators at Tuwaitha was only 640 grams with an average enrichment of 7.2%.

The design work for the third phase, the production phase, which proceeded concurrently with the other two phases, was finalised in 1987 and foresaw two identically equipped industrial scale plants, Al Tarmiya and Al Sharqat, each with 70 R120 separators for the production of uranium enriched to about 20% and with 20 R60 separators for the production of HEU (93%). The design production of each facility was 15 kg HEU per year, based on natural uranium feed, with the potential of a more than three-fold increase in that production by using LEU as the feed material.

A foreign civil engineering contractor was employed to construct many of the principal buildings at Al Tarmiya but according to Iraq, there was no foreign involvement in the construction of Al Sharqat.

Iraqi records show that installation and commissioning of R120 separators at Al Tarmiya commenced at the beginning of 1990 and that, by the time of the Gulf War, a total of eight R120 separators were in limited operation. Preparations had begun for the second group of seventeen R120 separators to be installed but nothing was accomplished. Iraq's declaration of the total enriched uranium produced at Al Tarmiya as some 685 grams at an average enrichment of 3% is equivalent to only about 20% of design, both in terms of mass and enrichment, but is not inconsistent with the reduced performance that might be expected during commissioning.

Iraq states that it had interrupted operations on the 15 December 1990 and that the damage caused by the bombardment prevented re-commencement.

Construction of the sister facility at Al Sharqat was about 80% complete at the end of 1990. There are no indications to suggest that any EMIS process equipment was ever installed.

1.2.2 Gaseous diffusion uranium enrichment.

a. Background

Iraq declared the existence of a programme to develop the gaseous diffusion process for uranium enrichment to IAEA-3, which arrived in Iraq coincident with the issue of Iraq's 7 July 1991 declaration, which did not include this information. Iraq stated that exploratory work on gaseous diffusion technology had commenced in 1982 with the intention of developing the capability either to directly produce highly enriched uranium or to produce low enriched uranium for use as feed material for the EMIS process. The Iraqi counterpart explained that work had initially concentrated on the development of suitable porous barrier material, on obtaining a theoretical understanding of flow through porous tubes and on diffusion plant cascade design. By 1985 some progress had been achieved in producing barrier material, therefore

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effort was also placed on compressor, diffuser and heat exchanger design. It rapidly became apparent that a very large industrial infrastructure would be required to manufacture these items and that this infrastructure was beyond the national capabilities at that time.

It was further explained that a decision had been made in 1987 to revise the mission of the team assigned to this task (Group One) such that priority was to be given to the exploitation of gas centrifuge technology for uranium enrichment. Some work on the gaseous diffusion process did continue, although it was limited to research and development on the barrier material and on carrying out practical tests on some compressors that had been procured. Iraq stated that its attempts to reverse engineer a screw compressor procured from the UK were unsuccessful.

b. Research and development

Work had commenced in 1982 with literature surveys of data on separation barriers, followed by experiments on porous tube manufacture and on the characterisation of porous materials. A number of materials, in various forms and deposited by various methods, were investigated during the following three years with little success, due to excessive pore size and unsatisfactory flow characteristics. Iraq claims that a suitable barrier material was developed in 1988 which overcame these adverse properties, but that the barrier tube was still found to be mechanically weak in industrial-scale handling.

In parallel with the above, a survey of compressors judged to be suitable for transporting the process gas was made and specifications were obtained from potential suppliers. Procurement action was taken to purchase compressors from companies in the USA, Germany, France and the UK and attempts were made to locally manufacture a compressor casing, but these were not successful. In 1987 design drawings of a screw compressor were made by reverse-engineering a screw compressor that had been procured from the UK. However, it was soon realised that reproduction of its components was beyond the capacity of the existing national engineering resources and, although some attempts were made to secure foreign assistance, nothing materialised. Concurrent with these activities, a facility for testing compressors was built at Rashdiya but, according to the Iraqi counterpart, was never commissioned due to the change in emphasis of the programme in favour of the centrifuge enrichment process.

Theoretical work on diffusion cascade behaviour and calculation of the performance of a total cascade made up of different sized stages acting in "square" cascade array were carried out. These calculations were for various cascade sizes ranging from 16 stages in series to 72 stages in series. Theoretical calculations aimed at optimising the geometry and flow parameters of the diffuser were also made.

Facilities were constructed initially at Tuwaitha, then later at Rashdiya, to test the theoretical models of the barrier design and the diffuser. These test facilities included

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capabilities to check barrier porosity, permeability, robustness and gas flow dynamics for tests with inert gas and with hydrogen fluoride (HF), fluorine (F) and the process gas (UF_6). Iraq states that, although a number of facilities to test barrier performance in UF_6 were planned, none were completed.

Barrier manufacturing facilities were commissioned to investigate the various proposed manufacturing processes, culminating in a laboratory scale production facility capable of making 18 test barrier tubes per day - several hundred were produced during its operating life-time. In 1986 Iraq proceeded with the plans to test a single barrier tube with UF_6. The tests were stated to have been carried out at Rashdiya in 1988, within Project 365, where one barrier was exposed to UF_6 for about four months and Iraq claims that promising results were obtained.

Iraq further planned to measure the separation factor of a complete single stage unit, initially using a mixture of two freons having very different molecular weights. A separation-test facility was constructed at Tuwaitha but severe difficulties were experienced in assembly due to the lack of robustness of the barrier tubes. Many were broken before an engineering solution was achieved. However, before the facility was commissioned, the entire project was moved to Rashdiya. The facility was dismantled and transferred to the new site and according to the Iraqi counterpart was never rebuilt.

In 1988 a barrier tube suitable for operation in UF_6 was successfully manufactured. The separation performance of a single unit (or stage) was theoretically determined and planning commenced on Project 366 through which to assess the barrier efficiency of 24 stages operating in series. The Iraqi counterpart states that this plan was never completed and that the project was cancelled in 1989. Two further facilities to measure the separation factor in UF_6 gas of a single diffuser stage unit and of 48 diffusers acting in series were also planned. The design of the former was completed but, due to the revised programme priorities established in 1987, was never constructed. According to the Iraqi counterpart, the design of the latter was never completed and the project was stopped when still at the basic design stage.

1.2.3 Gas centrifuge uranium enrichment

a. Background

As described by the Iraqi counterpart the team responsible for the development of gaseous diffusion technology (Group One) became independent from PC-3 in August 1987 and was renamed the Engineering Design Directorate – eventually to become the Engineering Design Centre (EDC). At the same time it relocated from Tuwaitha to premises (Rashdiya) in the north-western outskirts of Baghdad, which had formerly been a Ministry of Irrigation research and development establishment. The relocation was coincident with Iraq's recognition that the establishment of the engineering infrastructure that would be necessary to exploit gaseous diffusion on an industrial scale was beyond Iraq's current capabilities. Consequently, it was decided to focus the resources of EDC on the development of gas centrifuge enrichment technology with the aim of establishing a production capacity of 10 kg of highly enriched uranium (93% - HEU) per year by 1994. The facilities on the new site were rapidly expanded and modifications to existing buildings and new building construction continued until early 1991, as work on the centrifuge enrichment process gathered momentum.

Very little technical documentation is available to support Iraq's description of its work on gas centrifuge enrichment technology. There are very few technical reports and not one single example of an official programme report coded in accordance with the system described in the FFCD. However, Iraq has made available to the IAEA a large number of technical drawings from which it has been possible to understand the progression of the design of the various types of centrifuge machines considered in Iraq's development programme.

b. Research and Development

Work commenced in August 1987 with an attempt to develop the oil-bearing (Beams type) gas centrifuge for which extensive design information was available in open US literature. EDC's technical capabilities developed rapidly and, by late 1987, the first oil centrifuge (GS-1) was built and subjected to laboratory trials. Rotational speeds greater than 30,000 rpm could not be achieved due to vibration, high power consumption and vacuum difficulties.

In the face of these difficulties in the summer of 1988 EDC sought foreign assistance through H&H, a German company already involved in the supply of specialist machine tools to Iraq's armaments industry. H&H introduced two foreign nationals who had previously been employed by MAN - a German company that had, in the 1970's and early 1980's, been involved in the design, development and supply of centrifuges to URENCO, the European centrifuge enrichment company which produces low enriched uranium (LEU) for nuclear power station fuel. During the next 2 years the difficulties with unbalance and vacuum were gradually overcome as rotor dynamics and bearing know-how was learnt, with guidance from the ex-MAN employees, and by the import of high quality balancing machines and drive units. By mid-1989 a speed of 50,000 rpm was achieved in vacuum. These mechanical trials were followed by separation tests using a mixture of freon and carbon dioxide gas to simulate uranium hexafluoride (UF6) gas, the medium used in the centrifuge enrichment process. The separation tests which were carried out at a maximum rotational speed of 25,000 rpm, gave a separation factor of only 1.04, which was much lower than the theoretical value of 1.09.

By this time resources assigned to the development of the oil-bearing centrifuge were already being reduced in favour of development of the more efficient magnetic bearing centrifuge, internationally exploited on an industrial scale.

The shift of focus from the oil-bearing centrifuge was due to the provision, in the second half of 1988, by one of the ex-MAN employees, of a number of design drawings relating to early development designs of a magnetic bearing (Zippe type) centrifuge. As a consequence EDC applied most of its resources to the design and development of a magnetic-bearing centrifuge based on a maraging steel rotor rotating at sub-critical speeds.

During 1989 H&H introduced a further ex-MAN employee who, in co-operation with one of the original individuals, provided to EDC many detailed design drawings along with some 170 technical reports and specifications relating to the production and operation of centrifuges under development by URENCO in the 1970's. This information covered both sub-critical and supercritical centrifuge designs and also included some drawings for a three metre long supercritical machine under development, by MAN, in the early 1980's. None of these technical reports and specifications were included in the documentation made available by Iraq to the IAEA, and the few URENCO-related drawings included were of minor technical significance.

During the period from late-1988 through mid-1990 EDC produced a series of designs, each one initiated by information or advice deriving from the ex-MAN employees, and proceeded to attempt to manufacture trial quantities of centrifuge components. It was quickly concluded that Iraq's existing manufacturing capabilities were unable to produce the rotating components of centrifuge machines to the required accuracy and quality and, in the first instance, indigenous production was limited to stationary components. A decision was taken to strengthen the industrial infrastructure through the import of high quality, dedicated CNC machine tools, in most instances linking the purchase to the supply of quantities of demonstration components which were to be used for the assembly of development centrifuges.

Machine tool suppliers were approached in Germany, Yugoslavia, and Switzerland. Some orders for small quantities of components were placed with a German company and a UK company, which were not linked to the supply of machine tools. EDC's procurement strategy did not always proceed smoothly as demonstrated by the impounding, by the German customs authorities at Frankfurt airport, of machined maraging steel forgings, finished maraging steel components and CNC machine tools being supplied by a Swiss machine tool company.

In mid-1989 Iraq accepted the offer from one of the ex-MAN employees to provide design details of a sub-critical centrifuge based on a carbon fibre composite rotor and also to supply some trial rotors. Carbon fibre composite had many technical advantages over maraging steel and had become the material of choice in European commercial gas centrifuge enrichment plants. By the end of 1989 EDC had developed a series of sub-critical centrifuge designs based on the carbon fibre rotor and, by early 1990 sufficient components had been procured to support prototype centrifuge production and testing. The procured components included about 50 carbon fibre rotors supplied by ROSCH, the company owned by the ex-MAN employee who had sponsored the initiative.

In the spring of 1990 the first magnetic centrifuge using a carbon fibre composite rotor was successfully assembled and tested at an operating speed of 60,000 rpm over a period of several months in a mechanical test stand. In mid-1990 this centrifuge rotor was installed in a process test stand and about 100 hours of operation in UF_6 was achieved during the following 6 months. Although not fully optimised, a separative work output of 1.9 Kg SW/year was achieved with the prototype such that a cascade of 1,000 such centrifuges operating continuously for 1 year would have the capacity to produce 10 kg of 93% HEU.

The Iraqi counterpart explained that no enriched uranium was accumulated during the separation tests since, due to the limited quantity of UF_6 available, the enriched material produced was re-mixed with the resultant depleted material for re-feeding into the test centrifuge - a practice commonly adopted in test laboratories. The Iraqi counterpart maintains that the mechanical and process test stands were the only two test stands that were ever operated, and that a third test stand designed to accommodate two centrifuges operating in series or in parallel, planned for late 1990, was never implemented.

According to the Iraqi counterpart, its exploitation of the designs of supercritical centrifuges which it had acquired was limited and had been done on a spare-time basis, as the bulk of its resources were dedicated to the further development of its prototype sub-critical machine and preparations for its large-scale production. The counterpart stated that the studies done on supercritical centrifuge machines were focused on the design of a three metre machine, simply because the information it had obtained for this particular centrifuge design was far more complete than the information it had on a two-cylinder maraging steel rotor design, although Iraq had first received this latter information. Centrifuge experts consider that Iraq would have needed to gain practical experience with the manufacture and operation of simpler designs of supercritical centrifuge machines before progressing to exploit a three metre multi-cylinder machine.

Although Iraq had made modifications to buildings at Rashdiya and Al Furat to accommodate three metre centrifuge machines it insists that these actions were very forward-looking and should not be taken to indicate that Iraq had imminent plans to exploit this advanced design centrifuge. It is, however, relevant to note that only a few examples of the centrifuge drawings Iraq obtained from the ex-MAN employees have been made available to the IAEA and that the drawings contain only minor details.

c. Preparation for Production

In mid-1989, apparently confident of success in the exploitation of gas centrifuge enrichment technology, EDC contracted with both local and international

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organisations for the construction of the Al Furat facility, which was to accommodate the factory for the mass production of centrifuges and a pilot-scale cascade hall. As was revealed post-August 1995, Iraq had also planned to build a second large scale centrifuge facility in the Taji area which was intended to accommodate a cascade of up to 1,000 centrifuge machines and, according to the Iraqi counterpart, was to accommodate a commercial scale UF_6 production plant.

In parallel with the R&D effort, expedient procurement of raw materials had been initiated, particularly of materials subject to export controls by supplier states. Quantities ordered were sometimes far larger than required to meet the immediate goal, as typified by the procurement of 100 tons of maraging steel. Machine tool procurement was proceeding, although by mid-1990, deliveries were behind schedule. In the summer of 1990 Iraq received from H&H a flow forming machine which, according to EDC, was installed at Al Furat and enabled the flow forming of maraging steel rotor cylinders to commence on a trial basis. Around this time ancillary equipment for welding and heat treating maraging steel was also imported. Records indicate that only a few heat treatment tests were carried out and the test conditions chosen are clearly indicative of the availability of external advice.

The existence of Al Furat was revealed in late July 1991 during the IAEA's fourth inspection campaign; but Iraq continued to deny the existence of Rashdiya until 1993 and even then considerably understated its actual role. It was only after August 1995 that Iraq acknowledged more fully the role of the Rashdiya facility and reluctantly disclosed the plans for the development of the Taji facility.

In its efforts to obscure the extent of the gas centrifuge development programme Iraq had, in 1991, claimed that the plan was to manufacture only 200 centrifuges per year at Al Furat and even then expected a high initial reject rate. From the outset it was evident to the IAEA that the facility would have been capable of a considerably higher production rate - possibly as high as 5,000 machines per year, or sufficient to supply a facility with the capacity to produce 50 kg HEU/year. Existing buildings on the site were modified, one of which (B03) was used temporarily from Autumn 1990 for production development trials, a further building (B00) was almost complete in its refurbishment and was ready to accommodate CNC machine tools, delivery of which had already begun, when activities were suspended in 1991. Two large, purpose-designed buildings were under construction and at an advanced stage, although some 6 months behind schedule. One of these (B02) was being constructed by a UK company and the other (B01) by a German company, and both involved clean room technology.

Building B02 was to be used for flow forming, component cleaning, quality control and sub-assembly. Building B01 was intended for final assembly, single machine spin testing, cascade pipework manufacture and a demonstration cascade of 120 machines capable of producing about 1Kg HEU/year. To support the construction phase, H&H persuaded a small number of companies that had previous experience in centrifuge manufacture and plant construction as URENCO contractors to run

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training courses for Iraqi staff on corrosion of special steels, pipework fabrication and welding technology.

In parallel with these activities EDC was actively pursuing carbon fibre composite technology and in 1989 had ordered through the company ROSCH a purpose-built carbon fibre winding machine and a supply of carbon fibre filament and epoxy resin in order to establish an indigenous capability to manufacture carbon fibre composite cylinders for centrifuge rotors. The delivery to Iraq of these materials and equipment was initially prevented by the 1990 prohibition of exports to Iraq but a second attempt by Iraq was successful in achieving delivery of the equipment and materials to Jordan in 1991. This had been accomplished through a system of transhipment through an import/export agency in Singapore – the equipment and materials were not imported to Iraq and are under official custody in Jordan awaiting disposal by the IAEA.

Iraq's ambitious and rapidly developing programme for the design, development, manufacture and operation of gas centrifuge machines was not, according to the Iraqi counterpart, matched by a similar high priority plan for the secure supply of production-scale amounts of UF_6 - the basic feed material. Iraq has declared its laboratory-scale UF_6 production capacity to have been more than adequate to support the ongoing development activities in 1990 and considered that there was no urgency to provide for large-scale production. Despite this apparent lack of concern, Iraqi programme documentation indicates that designs for larger capacity UF_6 production plants were well advanced and civil engineering design was in progress.

Recognising the inevitable delays in the completion of Al Furat, a decision was made to construct an additional building at Rashdiya which would include a centrifuge hall to accommodate the pre-production-scale 120 centrifuge cascade. In the aftermath of the invasion of Kuwait, additional work was undertaken to adapt part of an existing building at Rashdiya to accommodate a 50 centrifuge cascade as part of the "crash programme" – see section 1.3.

1.2.4 Chemical and ion exchange uranium enrichment

a. Background

According to available Iraqi documentation, research and development into uranium enrichment through solvent extraction and ion exchange processes commenced in 1988. The decision to explore these enrichment technologies followed a review by the Iraqi Atomic Energy Commission (IAEC) of known enrichment methods and a similar review of the feasibility of a plutonium production reactor. The relocation and reassignment of Group One, which had been pursuing gaseous diffusion technology within IAEC Department 3000, during the summer of 1987, could have provided the impetus for these initiatives.

The stated objective of the investigation of these two additional enrichment methods was to provide an alternative supply of low enriched uranium (LEU) as the feed for its EMIS facilities – see 1.2.1.

Iraq had (and retains) a strong technical background in chemical processes. The Iraqi scientists involved in the solvent extraction programme were often also involved in the ion exchange programme. Petrochemical 3 (PC-3) Project documents indicate that Group Two Activities 2CC and 2CE contributed to the exploration of solvent extraction and ion exchange enrichment.

b. Chemical Enrichment (Solvent Extraction)

Iraq's programme for chemical enrichment by solvent extraction was modelled on the French CHEMEX solvent extraction process which was well described in open literature. Only rather elementary practical work seems to have been carried out on the CHEMEX process, but it was apparently enough to establish important fundamental factors. Although Iraq's efforts depended to a substantial degree on published information, it is clear that its scientists had a good understanding of solvent extraction technology.

Iraq stated that the goal of the chemical enrichment process was to provide LEU feed material (1.5-2.0 % U-235) for the EMIS process. The production scale design, described in a December 1990 PC-3 report, however, called for an annual production of 4-5 tonnes of LEU (3-4 % U-235). The differences between the enrichment level goals has not been resolved, but may be the difference between the theoretical goal (3-4 %) and expected practical results (1.5-2.0 %). The production-scale design foresaw about 50 stages and anticipated a separation factor of 1.0025.

A substantial amount of laboratory work was carried out in Tuwaitha pursuing basic studies designed to measure the separation factor, using 30-35% TBP (tri-buytl phosphate) as the extractant in a kerosene diluent, but by the time of the Gulf War such work appears not to have progressed beyond laboratory-scale.

The stated strategy was to address practical problems as they arose in scaling up to production processes, but it is clear that many significant technical challenges would have been met. The choice of an empirical approach rather than one based on a comprehensive theoretical understanding of the process would have complicated the resolution of practical problems.

Iraq attempted to procure a considerable amount of equipment to support this programme – notably an unsuccessful attempt to procure a complete engineering-scale test unit for the French CHEMEX process. Records indicate that imports by Iraq to support its research into chemical enrichment were limited to laboratory equipment such as mixer-settlers, pumps, distillation units, and pulse columns. According to the Iraqi counterpart, much of this equipment was destroyed during the aerial bombardment of Tuwaitha. Iraq had also placed orders for key pilot plant equipment such as glass columns and mixer-settlers, but the 1990 embargo on exports to Iraq prevented their delivery.

c. Ion exchange enrichment

Iraq's programme for ion exchange enrichment was modelled on the Japanese ASAHI technique, which was also well described in open literature. The goal of this programme, specified in an October 1990 report, was to establish the capacity to produce 5 tonnes of LEU (3% U-235) per year for use as feed material for the EMIS process.

Iraq appears to have made comparatively less progress in its work on ion exchange enrichment than it had in the CHEMEX process and had not yet addressed many of the more difficult technical challenges in scaling-up the process to production level. The work stopped at the laboratory scale at the onset of the Gulf War.

Iraq produced a total of about 100 kilograms of polyvinyl, phenylpyridine-based, macroreticular (highly porous) anion exchange resin in 20-kilogram batches over a two-year period. This resin choice is consistent with a programme based on the Japanese ASAHI technique. Experiments carried out using a four meter long, two centimetre diameter column achieved a separation factor of 1.0007. The experiments were conducted at a nominal pressure of 4 bar and a nominal temperature of 80 degrees Celsius.

A January 1991 PC-3 report documents Iraq's consideration of a combined solvent extraction/ion exchange enrichment process, in which the output of the solvent extraction process would have fed the ion exchange process with 1.5-2.0% LEU. The output of the combined process would have been 8% LEU, which was again intended to be used as feed material for the EMIS process.

1.2.5 Laser isotopic separation

In following up on Member State information, in August/September 1994, the IAEA (IAEA-26) was, after several days of statements to the contrary, able to obtain from Iraq a statement that the Laser Section (6240) within the Physics Department (6200) of the Iraqi Atomic Energy Commission had in 1981 been directed to work on Laser Isotopic Separation and to study both atomic (AVLIS) and molecular (MLIS) technologies.

The ensuing discussions revealed a poorly focused and poorly equipped programme which had endured until 1987, but had done little more than scrape the surface of either technology. This lack of achievement was due in part to the complexity of the technology and also to the difficulties experienced in obtaining critical controlled equipment, notably copper vapour lasers.

The inspection produced no indications that Iraq had reached the point of an integrated experiment that achieved any isotopic separation of either elemental uranium or UF_6 or that even the most rudimentary capabilities had been developed in either AVLIS or MLIS technologies.

IAEA-26 did, however, record its surprise that the relatively simple task of developing the technology for the production of uranium metal vapour had not been attempted or accomplished. After August 1995 it was learned that two attempts had in fact been made to construct a suitable vacuum chamber to facilitate AVLIS experiments. It was also learned that the second of these attempts had been successful and that the chamber had been equipped with an electron beam gun for the vaporisation of uranium metal. According to Iraq's statements, one experiment using two photon excitation was carried out in 1986 but did not produce conclusive results due, it was thought, to lack of precision in the design of the ion optics. A second experiment was carried out in 1989 after having optimised the equipment internal arrangements on the basis of results obtained from experiments with aluminium metal. The experiment with uranium metal proved to be inconclusive. It was explained that further work was abandoned due to the failure of the electron beam gun and because the low priority assigned to the research programme would not support the procurement of a replacement.

1.2.6 Summary

1. Iraq would have eventually achieved a measure of success in its EMIS programme but, based on reported performance, it would have required extraordinary good fortune in the commissioning of the Al Tarmiya plant for it to have produced 15kg of HEU before 1994. Had Iraq obtained supplies of LEU or chosen to divert from IAEA safeguards its holdings of 1.7 tonnes of LEU, it could have produced the same quantity about a year earlier.

2. The commissioning of the Al Sharqat EMIS plant would, around 1995, have provided Iraq with the capacity to produce 30 kg HEU per year. The use of clandestinely procured or produced LEU feed of 2.5% – 5 % enrichment could have resulted in a three or fourfold increase in this capacity.

3. The gaseous diffusion development programme suffered many technical set-backs and there were apparently many changes in plans which hindered progress, including the 1987 relocation of the programme from Tuwaitha to Rashdiya.

4. Iraq appeared to have been slow to recognise the extent of the industrial infrastructure that would have been required to support the large-scale exploitation of gaseous diffusion technology which, even by modern standards, is considered to be a complex technical process.

5. There is no evidence of any external help or advice having been given to the gaseous diffusion programme.

6. Although it is stated in the FFCD that all work on gaseous diffusion was stopped in 1989, discussion with the staff involved indicates that a small team had continued to work on barrier technology until the programme was interrupted by the Gulf War. At that time all rigs at Rashdiya were stated to have been dismantled and removed and the facility was sanitised in an attempt to remove all indications of its involvement in Iraq's clandestine nuclear programme. During the IAEA inspections of Rashdiya in the summer of 1991 no evidence of any continuing activities was detected.

7. It is unlikely that gaseous diffusion would be a technology of choice in a reconstituted nuclear programme.

8. Iraq's post-war efforts to conceal all centrifuge related documentation, the extent of its knowledge and the associated facilities and sites greatly complicated the IAEA investigations, particularly since much of the centrifuge documentation was stated to have been destroyed during the period when it was continually being moved from one hiding place to another. It cannot be ruled out that some documentation and some centrifuge components are still being deliberately withheld. In this context it is relevant to record that of the drawings and specifications provided by the ex-MAN employees, Iraq has handed over only a few relatively trivial examples to the IAEA.

9. From the information supplied by Iraq or uncovered by IAEA inspection teams, it is clear that EDC had made significant progress in gas centrifuge development in a relatively short time and had produced a prototype sub-critical centrifuge which it considered to be appropriate for large scale exploitation. This achievement – greatly accelerated by foreign assistance - is considered to be consistent with the time-scale and resources invested. It must be assumed that, without the interruption of the Gulf War, Iraq would have been in a position to build and commence to operate gas centrifuge pilot cascades of up to 100 machines around the end of 1991.

10. There is no evidence to contradict EDC's statement that they had not carried out multi-centrifuge tests through which they would have gained practical experience in the design and operation of gas centrifuge uranium enrichment cascades. The achievement of successful operation of centrifuge cascades is a complex task requiring considerable, time-consuming practical development work.

11. A total of about 1,000 centrifuges of the type developed by Iraq would need to have been operated continuously throughout 1993, in order to achieve the target of 10 kg of weapons grade HEU by 1994. The programme was behind schedule and it is doubtful whether the lost time could have been made up. The production workshops at Al Furat, once in operation, could easily have produced centrifuges

at a rate of several thousand per year, thus the post 1994 expansion of operating facilities would have been rapid.

12. Assuming progress could be sustained it is probable that the operation of cascades of the order of 1,000 machines could have been achieved around the end of 1994. This capacity alone would have contributed an additional 10 kg HEU to Iraq's annual production of HEU. However, if it is assumed that Iraq would have continued to add to its centrifuge based separative work capacity even at the relatively modest rate of 500 machines per year, the centrifuge programme, based on the 1991 single cylinder, sub-critical machine, could have produced around 140 kg HEU by the end of the year 2,000.

13. It is highly likely that carbon fibre composite rotors were to be adopted in favour of the maraging steel option and the Iraqi counterpart was confident that it would have been able to continue to circumvent the export controls on the specialised carbon fibre. This confidence appears to be justified by the fact that, even after the reinforcement of export controls following Iraq's invasion of Kuwait, it was possible for Iraq to procure, through a European agent, a major consignment (including carbon fibre and a purpose built computer numeric controlled winding machine), which was transhipped through Singapore to Jordan.

14. Iraq has claimed that it did no significant work on advanced (super-critical) centrifuge designs and that the modifications made to buildings at Rashdiya and at Al Furat, to accommodate such machines, were very forward-looking and should not be taken to imply Iraq's imminent intent to exploit such designs. Although there are no means available to verify these statements they are, nevertheless, considered to be consistent with Iraq's programme resources and the related time frame.

15. From the available evidence it would appear that the plan to fabricate gas centrifuges and construct and commission a fifty machine cascade within a six month period around the end of 1990 was wildly optimistic and available evidence suggests that work had barely commenced when the conflict started.

16. Iraq's stated lack of concern about the absence of production-scale UF_6 capacity is not consistent with its ambitious and rapidly developing programme for the design, development, manufacture and operation of gas centrifuge machines. Although the civil engineering designs for such a facility appear to have been well advanced there are no indications that construction work had begun.

17. Although in 1991 EMIS was still Iraq's process of choice for the production of highly enriched uranium there is little doubt that gas centrifuge enrichment would be the process of choice for a reconstituted enrichment programme.

18. Although the number of technical reports for the solvent extraction and ion exchange programmes is limited, the information contained is consistent with

programmes orientated toward practical design studies, which tends to confirm Iraq's statement that theoretical chemists were not involved. The available technical reports were almost all issued in 1989 and 1990 and are thus consistent with programmes developed as a result of the 1988 IAEC review of enrichment technologies.

19. It is highly unlikely that Iraq would have invested further effort in the large-scale exploitation of LIS as a means of production of highly enriched uranium.

1.3 The intended diversion of research reactor fuel

1.3.1 The "crash programme"

Following the August 1995 departure from Iraq of the late Lt. General Hussein Kamel, Iraqi authorities revealed to the IAEA a plan, stated to have been initiated by Hussein Kamel shortly after Iraq's August 1990 invasion of Kuwait, to divert from IAEA safeguards the highly enriched uranium (HEU) contained in the fuel of the two research reactors on the Tuwaitha campus of the Iraqi Atomic Energy Commission (IAEC) and to use this material to produce the core of a nuclear weapon.

This plan, referred to as the "crash programme", is one of the most substantial items of information revealed by Iraq during the high level technical talks in August 1995. In this regard the IAEA was provided with technical reports and engineering drawings describing the practical steps planned to be followed in the recovery of the HEU from the research reactor fuel and its subsequent conversion to metallic form as raw material for the production of the core of a nuclear weapon.

Although, as stated by the Iraqi counterpart, the plant for the recovery of the HEU had been built and fully commissioned, the simple fact that the IAEA successfully accounted for the entire inventory of the HEU reactor fuel, in May/June 1991, clearly shows that the campaign for actual extraction of the HEU from the reactor fuel was not initiated.

Had the crash programme been carried through it could have reduced the time for Iraq to fabricate its first nuclear device by as much as two years.

The inventory of enriched uranium research reactor fuel under IAEA safeguards, as of April 1991 is shown in Table 1.3 below.

1.3.2 The recovery of the highly enriched uranium – Project 601/603

As recorded in a series of Iraqi technical reports, Project 601 was established in August 1990 with the objective of extracting the highly enriched uranium (HEU) from research reactor fuel for use as the core material of a nuclear weapon. A chemical plant, based on solvent extraction technology, was designed and its components fabricated and installed in the hot cells of the Active Metallurgy Testing Laboratory (LAMA), Building 22, on the Tuwaitha site.

The team working on this project had already accumulated experience from its laboratory-scale work on the separation of plutonium from irradiated natural uranium fuel rods and was confident that it would be able to achieve its objective. The throughput of the plant was designed to accommodate the processing of one, possibly two, fuel elements per day such that the recovery of the HEU from the 69 fresh and 38 lightly irradiated fuel elements could have been accomplished within 2 to 3 months, thus making available some 26 kg of HEU, in the form of UNH containing 22.4 kg of the isotope U-235, less process losses.

The next phase of the plan would have involved the processing of the highly irradiated HEU reactor fuel, making available a further 14 kg of HEU containing some 10 kg of the isotope U-235. This phase of the project would present a greater technical challenge because of the need to remove considerable fission product contamination from the separated uranium - the process losses would most likely be significantly higher.

PC-3 report 1556 of 3 January 1991 includes calculated data from which to estimate the fission product content of 62 irradiated fuel elements (80% enriched) based on tabulated data of the burn-up and cooling-time of each element. These 62 elements, together with the 34 elements remaining in the core of the IRT-5000 reactor, represented the total inventory of 96 irradiated fuel elements of 80% enrichment, as verified by the IAEA on 19 November 1990. The report also calculates the typical fission product content of the much more lightly burned-up 93% enriched fuel from the Tammuz 1 reactor.

Other less significant phases of the project would have involved the recovery of the uranium from reactor fuel of lower enrichment, much of which was highly irradiated.

The design, fabrication and installation of the chemical plant was completed within a period of little more than three months, which enabled the plant to be commissioned using unirradiated natural uranium solutions during December 1990. The Iraqi counterpart stated that the plant was ready to receive HEU feed material in early January 1991 and clearance had been sought from Hussein Kamel to commence actual operations. According to the Iraqi counterpart, no such clearance was received and the fuel elements remained intact apart from the end-caps having been cut from three elements to facilitate their feeding into the input acid dissolution tank. The LAMA building was seriously damaged during the January 1991 bombing of

Tuwaitha and, according to the Iraqi counterpart, the plant components were salvaged and placed in temporary storage at the Al Shakili storage complex adjacent to the Tuwaitha site.

Again according to the Iraqi counterpart, and supported by PC-3 technical documentation, when it became clear that the project could no longer be housed in the LAMA building, the uranium recovery plant was redesigned – as Project 603 - in order that it could be re-installed at the Al Tarmiya site which had sustained lesser bomb damage. The technical documentation describing Project 603 indicates that it was to be limited to recovering the HEU from the fresh fuel elements and to convert the recovered material to the form of UO_2. The UO_2 material was then to have been transferred to Project 247 where it would have been converted to UCl_4 in which form it could have been used as feed for EMIS separators and enriched to 93%.

1.3.3 The further enrichment of the highly enriched uranium – Project 521C

According to the Iraqi counterpart, it was planned to further enrich the uranium recovered from the irradiated HEU reactor fuel employing a 50 machine centrifuge cascade which was to be designed, fabricated and installed in Hall 9 of the EDC establishment at Rashdiya. According to the Iraqi counterpart the centrifuge machines were to be constructed partly from components already procured from foreign suppliers and partly from components ordered from Iraqi engineering companies.

Again, according to the Iraqi counterpart the cascade was anticipated to include a mixture of centrifuge types, differing principally with regard to the rotor type – either carbon fibre or maraging steel. The counterpart maintains that no attempts were made to assemble centrifuge machines from the available components but expressed confidence that when all the components required for the cascade were available they could have assembled the machines at a rate of at least one per day.

The basic civil engineering modifications were stated to have been made to Hall 9 and concrete foundation strips had been cast, on the existing floor, to accommodate a cascade of two parallel lines of 25 machines. Although some shuttering had been assembled, none of the concrete mounting blocks for the centrifuge machines had been cast before the post-war decision was taken to abandon the project sub-task.

According to the Iraqi counterpart, in order to conceal the preparations for Project 521C, the concrete foundations, cast on the floor of Hall 9, were removed and the concrete floor tiles were stripped from the entire floor area. The hall was also filled with sacks of cement which inhibited access for inspection. When the emptied hall was inspected in 1996, it was still possible to observe, what was stated by the Iraqi counterpart, to have been the civil engineer's markings on the walls, indicating the planned locations of the two lines of centrifuge machines.

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The Iraqi counterpart declared that not one single machine was completed for Project 521C and consequently no uranium was introduced into Hall 9. Although there is no evidence to refute this declaration there is no documentary evidence to support it.

1.3.4 Conversion to metal of highly enriched uranium – Project 602/602B

Project 602 was designed to receive the recovered HEU from Project 601 in the form of UNH and to convert it to metal form which would be the feed material for casting the core components of the nuclear weapon. The project was housed in Tuwaitha Building 64 and involved plant stages for the conversion of the input UNH through UO_4 to UO_2, the conversion of UO_2 to UF_4, the reduction of the UF_4 to uranium metal and systems for waste recovery. The plant stages for the conversion of the UNH to UO_4 were designed on the basis of laboratory-scale tests and were fabricated, installed and commissioned using natural uranium feed.

The basic technology for the preparation of UF_4 was already well established and an existing UF_4 /uranium metal project, with a capacity of 20 kg uranium metal per day, designed around the end of 1989, was adopted for Project 602. This plant stage had been installed, commissioned and had produced a 10 kg test batch of natural UF_4 around the end of 1990. The reduction of UF_4 to uranium metal presented little technical challenge as the process had been in use for natural uranium since mid-1986. The principal development work required in this area was to improve techniques in order to compensate for the process losses that would otherwise result from the small batch size of some 100 g that had been selected by the project managers. Although the waste recovery plant stages were not yet installed it can be accepted that the capability to commence the conversion of HEU from UNH to metal was essentially available in January 1991.

Building 64 was severely damaged in the January 1991 bombardment of Tuwaitha and the project could no longer proceed in that building. The undamaged plant equipment was salvaged and stored pending reconstitution of the capability. The project was redesigned and documented as Project 602B, but, according to the Iraqi counterpart, no practical measures were taken to reconstitute the capability. According to the Iraqi counterpart, the plant components that had been commissioned and thus contaminated with natural uranium, were unilaterally destroyed, while other general purpose components were retained for subsequent use in non-nuclear activities.

1.3.5 Summary

1. Since the IAEA was able to account for all of the research reactor fuel, Iraq did not make any practical progress in the recovery of the HEU material. Had Iraq been able to proceed, it is possible that the HEU material from the fresh and lightly irradiated reactor fuel could have been recovered and made available in metal form around the middle of 1991.

2. The counterpart's statement that, following the aerial bombardment of Tuwaitha, action was taken to redesign the HEU uranium recovery and the HEU uranium metal preparation plant for re-installation at alternative locations provides clear indications that the "crash programme" was not abandoned in January 1991. Indeed the fact that the redesign documents, provided to the IAEA by the counterpart, are dated 8 June 1991, might indicate that the "crash programme" was not abandoned until it became evident to Iraq that the reactor fuel was to be removed from the country (the first shipment took place in November 1991).

3. The FFCD is unclear regarding the role of the centrifuge enrichment Project (521C) as to whether it was planned to further enrich the HEU recovered from both the fresh and irradiated 80% enriched reactor fuel or whether, more logically, the project was to be used to re-enrich the uranium recovered from the irradiated 80% reactor fuel and perhaps that from the 36% enriched reactor fuel. Although to considerably different degrees, the recovery of the HEU from these latter two categories of fuel would have presented a significant additional technical challenge owing to the necessity to purify the recovered HEU from fission product contamination.

4. The civil engineering arrangements for Project 521C were well in hand, but no significant progress was made with the fabrication of centrifuge machines or the construction of the cascade, because Iraq lacked sufficient numbers of imported components and as indicated in programme documentation, was unable to indigenously manufacture such components. Furthermore it had not yet developed the ability to produce rotor cylinders from either maraging steel or carbon fibre composite due, in this latter regard, to the hold-up, in Amman, Jordan, of critical components and equipment.

5. The implications of Project 603 - the post-January 1991 redesigned version of Project 601 – is that Iraq planned to use EMIS to re-enrich the HEU recovered from the fresh 80% enriched reactor fuel. This is certainly feasible and could have been accomplished in a few months given the availability of a small number of fully operational separators. In this regard it is noted that Iraq's inventory of all EMIS separators, both development and production models, has been verified and found to be consistent with the scope of this programme activity, as described in Iraqi technical documentation in the possession of the IAEA. All major components of the EMIS programme have been destroyed or rendered harmless.

6. Iraq had or would have quickly developed the necessary technologies to be able to recover the HEU material from the fresh and lightly irradiated research reactor fuel and to convert it to metal form to be used as the raw material from which to fabricate the core of a nuclear weapon. In so doing Iraq could have shortened the time that would have been required to produce its first nuclear weapon from indigenously produced HEU by as much as two years.

7. Given Iraq's declared intention to recover the uranium from the entire inventory of research reactor fuel (about 41 kg U-235 allowing for burn-up), it must be assumed that the time to produce a second weapon would also have been reduced, despite the greater technical complexity involved in the recovery of uranium from highly irradiated fuel.

8. Due to the results of the Gulf War, Iraq was unable to proceed with the "crash programme" and thus unable to produce a nuclear weapon. The fact that Iraq planned to divert nuclear material from IAEA safeguards further indicates that Iraq was not successful in its other endeavours to produce significant amounts of weapons-usable nuclear material.

Table 1.3.

Iraq's research reactor fuel inventory
as verified by the IAEA on 19/20 November 1990

Enrichment % U-235	Number elements	Irradiation Status	Uranium content kg	U-235 content kg	Comments
93	1	Fresh	0.417	0.389	Test element
	38	Irradiated	11,874	11,050	Very low burn-up
80	68	Fresh	13,722	10,998	
	62	Irradiated	12,379	9,978	2-12 years cooled
	34	Irradiated	6,812	5,482	Reactor core fuel
36	10	Fresh	3,538	1,272	
	3	Irradiated	1,002	0.360	> 8 years cooled
10	69	Irradiated	87,760	8,776	> 8 years cooled

Mass data are not corrected for burn-up.

1.4 The production and separation of plutonium

1.4.1 The indigenous reactor – Project 182

a. Background

As confirmed by Iraqi documentation, Project 182 was established in late 1984 with the objective of designing and constructing a natural uranium fuelled, heavy water moderated and cooled reactor of some 40 MW (Th) capacity modelled on the Canadian NRX research reactor. The timing of the establishment of the project was explained to coincide with Iraq's realisation that there was no longer any hope that France would rebuild the Tamuz-1 reactor that had been destroyed in the Israeli air attack of 7 June 1981. The same documentation shows Project 182 to cover reprocessing and the production of plutonium metal, indicating that the reactor would have been used as an alternative source of weapons-usable nuclear material.

b. Development

There are no indications that the design of the reactor progressed beyond theoretical studies. An Iraqi document reviewing the status of the project as of May 1988 indicates that no decision had yet been made as to whether the fuel would be in the form of ceramic oxide or metallic uranium. In discussion with the IAEA, the project leaders explained that the priority allocation of resources to the EMIS programme had, for all practical purposes, put Project 182 "on hold".

This statement is supported by available Iraqi documentation which includes a letter, dated 21 June 1988, indicating that consideration was being given to the conversion of Project 182 to an "open project" and seeking the co-operation of the IAEA, or other international parties to facilitate its implementation. However, a subset of Project 182 dealt with the indigenous production of heavy water and a PC-3 report, issued on 22 October 1990, reviewing public-domain information on the two most widely utilised production processes, which indicates that Project 182 had not been totally abandoned.

1.4.2 The use of the IRT 5000 reactor

Iraq's use of the IRT-5000 reactor in its reprocessing research and development activities was twofold. Firstly an irradiated IRT-5000 reactor fuel element (10% enriched uranium – EK10) exempted from IAEA safeguards at Iraq's request, was reprocessed and, secondly, three indigenously fabricated natural uranium fuel elements were irradiated in IRT-5000 and also reprocessed. While it is clear that the IRT-5000 reactor made a useful contribution to Iraq's research and development programme, it was of very limited usefulness as a plutonium production reactor.

1.4.3 The separation of plutonium

A laboratory-scale process line, Project 22, based on PUREX technology, was built and successfully commissioned in the hot cells of the radiochemical laboratory at Tuwaitha (Building 9). Three reprocessing campaigns were carried out during the period from April 1988 through April 1990, the first two of which involved the reprocessing of EK10 fuel pins and the last the reprocessing of pins from three "home-made" (EK07) fuel cassettes. Through these reprocessing campaigns Iraq separated some five grams of plutonium and recovered about 11 kg uranium.

Through Project 22 Iraq also successfully completed a laboratory experiment to produce milligram quantities of plutonium metal employing classical "bomb-reduction" techniques. As previously reported, these undeclared activities were in contravention of Iraq's safeguards agreement with the IAEA.

1.4.4 Summary

1. Iraq had not discounted the plutonium route for the production of weapons-usable nuclear material but had made no practical progress towards the development of a plutonium production reactor.

2. Iraq has demonstrated its capabilities in reprocessing technology through its design and cold-commissioning of Project 601, the pilot-scale chemical plant for the recovery of highly enriched uranium from reactor fuel.

3. Iraq has demonstrated its capability for the laboratory-scale reprocessing of irradiated fuel for the extraction of plutonium and its reduction to metal. There are, however, no indications of any larger scale activities.

2. Weaponisation

2.1 Background

Although Iraq had initiated its programme to produce weapons-usable nuclear material in 1983, it contends that no practical steps towards establishing weaponisation capabilities commenced until the end of 1987. Documentation provided by Iraq, in response to IAEA insistence, following the high level technical talks of August 1995, corroborate Iraq's contention. The documentation shows that, in early 1987, the Al Hussein Project was established under the direct supervision of the chairman of the IAEC, and comprised a small group of individuals tasked to assess the resources, investment and period that would be required to achieve the first nuclear weapon. The Al Hussein Project delivered a summary report in November 1987 which, according to the Iraqi counterpart, met with strong criticism and led to the establishment, within IAEC, in April 1988, of a weaponisation team known as Group Four.

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With the transfer from IAEC in, November 1988, of Department 3000 and its establishment, in January 1989, as PC-3, within the Ministry of Industry and Military Industrialisation (MIMI), nuclear weapon development activities were divided between PC-3, which was responsible for weapons design, fabrication and testing, and the Dhafer Project, at Al Qa Qaa, which was responsible for the production of high explosive lenses. The initial activities of Group Four were carried out at the Tuwaitha Nuclear Research Centre until May 1990 when, with the exception of the Theoretical Studies, Reprocessing, and Uranium Conversion Departments, which remained at Tuwaitha, Group Four moved to its new premises at Al Atheer.

2.2 Facilities

As the principal nuclear research centre in Iraq, Tuwaitha had the facilities and infrastructure for all Group Four activities except for the fabrication, handling and testing of high explosives. Theoretical studies, based on the use of mainframe and personal computers, electrical design studies, and development of dedicated instrumentation were carried out in regular buildings at Tuwaitha. Radiochemistry experiments, including the separation of a few grams of plutonium, took place in the hot cells of Building 9. Studies of uranium metal production and casting were conducted as part of the activities related to fuel fabrication and used facilities in Buildings 15 and 73.

Al Atheer was specifically designed to accommodate all technical activities related to nuclear weapon development, including experiments with high explosives for which an elaborate complex was designed and constructed. The complex included a heavy-duty bunker (Site 100) and an internal explosion chamber (Site 6600). Site 100, which was capable of handling experiments involving several hundreds of kilograms of high explosive, was completed as early as 1989. The design of the internal explosion chamber included a high integrity containment system to prevent the release of radio-toxic materials used in neutron initiators. The construction of Site 6600 was still uncompleted when the project was interrupted at the beginning of 1991.

Uranium metallurgy studies and fabrication, both for natural and highly enriched uranium, were to be accommodated in an extremely large building (6830) equipped with a sophisticated air handling system. Another building (430) was designed to accommodate equipment and facilities for the machining of uranium metal. Both buildings were still under construction at the end of 1990.

A powder metallurgy building, which was already equipped with large industrial hot and cold isostatic presses, was close to completion at the end of 1990. However, the unprotected siting of these presses indicates that they were not intended for work with high explosives.

Other buildings were designed for material characterisation, dynamic testing of materials, neutron source testing, device assembly and storage. Dedicated facilities

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were also provided for civil engineering support activities and mechanical and electrical design activities.

When completed, Al Atheer would have been equipped to develop, fabricate and cold test the nuclear device and its individual components. All the technically significant buildings, as well as the related equipment at Al Atheer, were destroyed under IAEA supervision in April and June 1992.

Al Qa Qaa, which was Iraq's main facility for the production of conventional high explosives, detonators and missile propellants, had the infrastructure to support the initial activities of the Dhafer Project in the development of the high explosive package for a nuclear weapon. Al Qa Qaa held large stocks of imported HMX and RDX and had its own operating RDX production plant.

However, as the work of the Dhafer Project progressed, contracts were entered into with foreign suppliers to build turnkey research and development facilities for pyrotechnics and for the production of shaped high explosives, and associated experimentation. A contract for the construction of RDX and HMX production facilities at a location near Falluja was also concluded.

Civil engineering work began on all these contracts and some equipment was provided, but the August 1990 embargo, imposed by Security Council resolution 661, halted all projects before completion.

Existing indigenous facilities, including a number of buildings previously used for missile composite propellants, were used for the production of various detonator types and for pressing and casting shaped high explosives.

A location in south-western Iraq was selected for underground nuclear testing on the basis of criteria documented in Iraqi technical reports. This site was to have been available by the end of 1991, but Iraq has stated that the definitive location had not been selected and that no construction had started before the Gulf War.

2.3 Research and Development

As documented in PC-3 technical reports, Group Four's theoretical activities concentrated on studies of the requirements of a implosion weapon "fuelled" by HEU - the study of a gun type weapon having been abandoned in 1988, because that design was known to require several times the amount of highly enriched uranium (HEU) than an implosion design. Group Four nuclear weapon design reports indicate that Iraq's weapon design relied heavily on information available in open literature.

Theoretical studies led to the development of various computer codes to evaluate the performance of a given design. These codes were also obtained from open literature and were adapted to Iraq's available mainframe computer. Group Four undertook to adapt the codes and to develop the physical constants, such as equations of state, neutron cross-sections, and the constitutive models, which it assessed the nuclear weapon development programme needed. Although the available Iraqi documentation indicates that Iraq's primary focus was a basic implosion fission design, fuelled by HEU, the same documentation also indicates that Iraq was aware of more advanced weapon design concepts, including thermonuclear weapons. Group Four also invested significant efforts in understanding the various options for neutron initiators.

In the area of electronic and electrical design, Iraq was developing its own instrumentation to be combined with imported equipment such as streak cameras and oscilloscopes. Fast electronic components, flash X-ray devices, and sensors of various types were also under development. Nonetheless great reliance would have been placed on imported equipment. As recorded in PC-3 documentation and summarised in the FFCD, Iraq was developing an arming, fusing, and firing system for a 32-point detonation system.

The Dhafer Project followed a largely empirical development programme in its work to produce high explosive lenses for the implosion package. Until the first half of 1990 the project concentrated on the use of pressing to form the lenses but the size limitation imposed by the available equipment resulted in a transfer of effort to high explosive casting technology. Development of plastic bonded explosives did not progress beyond laboratory-scale production.

Iraq acknowledges testing single pressed lenses but states that no cast lenses had been produced by January 1991 and thus none had been tested. Iraq claims not to have conducted four-pi tests or any test of multiple lens arrays. There is no means available to the IAEA to verify this claim.

PC-3 documentation shows that Iraq had made significant progress in developing capabilities for the production, casting and machining of uranium metal. However, Iraq maintains that Group Four had not progressed beyond casting centimetre-sized test-pieces to casting full-scale pieces due to the delayed importation of adequate furnaces. Nonetheless, Iraq acknowledges casting a uranium sphere of about five centimetre diameter, several hemispheres of similar size and a small number of rods, weighing 1.2 kilogram per piece, from which to machine “sub-calibre munitions”.

2.4 Missile delivery system

Consideration of a missile delivery system for nuclear weapons is shown, by available Iraqi documentation, to have commenced as early as 1988 in a meeting attended by a senior deputy minister of the Military Industrialisation Corporation. However Iraq claims that no further interaction took place until the end of 1990, when the need arose to liaise regarding integration of the nuclear weapon which was to have been produced through the "crash programme" with a missile delivery system.

The nuclear weapon in the mid-1988 conceptual design was deemed too heavy to be delivered by existing Iraqi missiles and Group Four was tasked to modify the design "with a view to reducing the total weight of the projectile to about one ton or less". In discussions with the counterpart it appears that the long-term plan was for a delivery vehicle based on the engine that was being developed for the second stage of the Al Abid satellite launch vehicle.

The options considered for the "crash programme" were stated to involve either the urgent production of a derivative of the Al Hussein/Al Abbas missile, designed to deliver a one-tonne warhead to a maximum range of 650 km, or to accept the fall back option of using an unmodified Al Hussein missile and to accept a range limitation of 300 km.

2.5 Programme documentation

Iraq's assessment of the technical requirements for the development of a nuclear weapon are well documented in a series of original Iraqi reports dated June 1988. Group Four's achievements in nuclear weapon development are also well documented through autumn of 1990. The most significant of this documentation are the following:

- The "Al Atheer Progress Report" (PC-3 report # 1409) obtained by IAEA-6. This report remains the only significant weaponisation report directly obtained and retained in the custody an IAEA inspection team.

- The June '90 to June '91 Al Atheer Achievement Report (Group 4 report # 991002), provided to the IAEA by Iraq in August 1995. This document was published in September 1991 and provides the status of progress in weaponisation at that time, along with an assessment of the disturbance created by the war and the measures taken to salvage Al Atheer equipment.

- PC-3 Report 821 (Rev. 5), provided, by Iraq to IAEA-28 in September 1995.

- Some 270 Group Four reports provided by Iraq on an optical disk to IAEA-29, in October 1995. Iraq claims that this disc includes all the reports published by Group Four.

- A small number of preliminary drawings of neutron initiators and detonator holders, which Iraq provided, on aperture cards, during the August 1995 high level technical talks.

- Group Four computer codes provided by Iraq to the IAEA in 1992 and 1996.

- The lens design code provided, by Iraq, to IAEA-29 in October 1995 which was used to calculate the slow/fast explosive interface, based on the density, detonation velocity, and characteristic dimensions of the lens.

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- The July 1990 Lens Design and Detonator Synthesis Reports provided by Iraq to IAEA-28 in September 1995.

- Various design drawings contained in the Haider House Farm cache of documents provided by Iraq to the IAEA in August 1995. The cache contains an almost complete set of drawings of lens moulds, dated 13 October to 24 December 1990, but there are gaps in the series at potentially critical points.

On the other hand missing documentation affecting the completeness of information of Iraq's weaponisation capabilities include:

- Al Qa Qaa: progress reports, production process records, experimental set-ups and results, communications with bodies outside the Dhafer project, such as Al Qa Qaa commercial department, PC-3 or contractors.

- Al Atheer: design drawings for any of the nuclear weapon components (even in a preliminary stage), drawings for the integration of the weapon with the delivery system, additional documentation on the planning and results of experiments carried out after mid-1990, description of either the buildings at Al Atheer or the equipment installed or planned to be installed at the end of 1990.

- Documents related to the collaboration between Group Four and the other parts of the IAEC, in critical areas such as tritium production or neutron generators, as well as between Group Four and its missile counterparts.

- Documents providing precise lens dimensions for a specific nuclear weapon design – the lack of lens drawings is problematic, since the shape of the lens mould does not adequately indicate the final shape of the lens.

2.6 Summary

1. Iraq's insistence that it had not finalised a nuclear weapon design option at the time of the Gulf War complicates the task of evaluating Iraq's weaponisation capabilities at that time. However, although there are gaps in the documentation of Iraq's weaponisation activities, it appears that Iraq's declared progress towards developing practical capabilities, particularly uranium casting and machining and the production of explosive lenses for the implosion package, is consistent with Iraq's resources and the time frame of the programme.

2. Evaluation is further complicated by Iraq's long history of denial of the actual purpose of the Al Atheer nuclear weapons development and production facility and its persistent understatement of the scope and achievements of its weaponisation efforts, even in the post August-1995 era. Nonetheless, Iraqi programme documentation records substantial progress in many important areas of nuclear weapon development, making it prudent to assume that Iraq has

developed the capability to design and fabricate a basic fission weapon, based on implosion technology and fuelled by highly enriched uranium.

3. While PC-3 has stated itself to be well aware of the fundamental basis of boosted fission weapons and thermo-nuclear weapons and Iraq was already investigating methods for the isolation of the Lithium-6 isotope, there are no indications of its imminent intention to exploit either technology.

4. Iraq's statement that all weaponisation activities ongoing at Al Atheer ceased as a result of the aerial bombardment in January 1991 is supported by the Al Atheer progress report, dated 10 September 1991 and covering the period from 1 June 1990 through 7 June 1991. However that same report contradicts Iraq's statement that its clandestine nuclear programme was effectively abandoned at that same time, by a statement, presumably by the Director General of Group Four, that "the factory is able to continue the implementation of its work-plan in spite of the material damage we have suffered", by which, in July 1997, he acknowledged that he had meant that Group Four could continue the nuclear weapons mission. The same report also included a proposal for the repair of Site 100, the heavy-duty high explosive external test bunker, and qualified as "important" some equipment useful only in the context of the continuation of the programme. In a letter dated 15 September 1997, the Iraqi counterpart disavowed the statement of the former Director General of Group Four, and characterised the statement as a personal opinion rather than the official Iraqi position.

5. Weaponisation is clearly the most sensitive aspect of Iraq's clandestine nuclear programme and is regrettably the area where Iraq has been most reluctant to enter into open discussion and where it has persisted in a continuing policy of understatement. The IAEA has made considerable efforts to persuade Iraq to co-operate in an endeavour to account for all of the materials and equipment that had been assigned to Group Four and listed in the final Al Atheer progress report. It was not until after the technical talks in May 1997 that Iraq responded to this need and in July, made available to the IAEA a large number of pieces of equipment formerly assigned to Activities 40B and 40G of Group Four which it explained had been found as the result of a search of a large number of facilities by a group of personnel formerly directly involved in the work of Activities 40G and 40G. As none of these items could be regarded as vital to a reconstituted nuclear weapons programme, it is difficult to understand why Iraq had not, long ago, made them available.

Attachment 2. Chronology of major events

Date	Event	Comment
1991		
910403	UNSCR 687 (1991) adopted.	UNSCOM and IAEA Action Team established.
910406	Iraq accepts UNSCR 687.	
910415	IAEA establishes Action Team.	Responsible for planning and co-ordinating Agency's implementation of UNSCR 687.
910418	First Iraqi Declaration.	Denies having nuclear weapons or weapons-grade nuclear material.
910419	IAEA letter to Iraq regarding declaration.	Agency questions accuracy of 910418 declaration.
910427	Second Iraqi Declaration.	Declares nuclear materials already subject to IAEA safeguards and lists facilities at Tuwaitha and Al Qaim.
910515	IAEA submits plan to UNSC.	Implements UNSCR 687 task to destroy, remove, and render harmless Iraq's nuclear capabilites.
910515 910521	IAEA 1.	IAEA inspects declared sites and Tarmiya.
910617	UNSCR 699 (1991) adopted.	UNSC approves IAEA plan for destruction, removal and rendering harmless of items specified in Para. 12, UNSCR 687 (1991).
910622 910703	IAEA 2.	Iraq denies access to two sites, fires warning shots at inspectors.
910630 910703	High Level UN Mission to Iraq.	Reports Iraqi response falls short of requirements of UNSCR 687 (1991).
910707 910718	IAEA 3.	Reveals large stocks of natural uranium and existence of various uranium enrichment programs.
910707	Third Iraqi Declaration.	Declaration maintains that Iraq had complied with NPT and IAEA Safeguards Agreement. Discloses clandestine centrifuge, chemical, and EMIS uranium enrichment programs. Does not disclose Al Atheer.
910709	IAEA letter to Iraq regarding third declaration.	Letter points out uranium enrichment programs should have been declared under Safeguards Agreement.
910710	Iraqi reply to IAEA letter of 910709.	Letter attempts to justify failure to declare uranium enrichment programs.

910711	Second IAEA letter to Iraq regarding third declaration.	Letter points out nuclear material should have been declared under Safeguards Agreement.
910712	Iraqi reply to IAEA letter of 910711.	Letter attempts to justify failure to declare nuclear materials.
910718	Board of Governors adopts resolution declaring Iraq has not complied with safeguards agreement.	Report also sent to UNSC and UNGA.
910727 910810	IAEA 4.	Conducts detailed assessment of EMIS program.
910728	Iraq submits additional list of nuclear material to IAEA 4.	List of materials includes items not previously declared.
910729	IAEA submits plan for ongoing monitoring and verification (OMV).	OMV Plan called for by UNSCR 687.
910815	UNSCR 707 (1991) adopted.	Demands Iraq halt all nuclear activity, provide full disclosure of its weapons programs, and provide UNSCOM and IAEA inspectors immediate, unrestricted, unconditional access to all sites. Declares Iraq to be in material breach of UNSCR 687.
910914 910920	IAEA 5.	Concentrates on Iraqi declarations concerning nuclear materials, plutonium extraction, and uranium enrichment.
910921 910930	IAEA 6.	Inspectors detained in parking lot for four days after discovering documentation relating to Iraq's nuclear weaponisation program. Documentation seized by inspectors forcibly confiscated by Iraq and returned to inspectors after a period of about six hours. Iraq removes all documents referring to PC-3 Group Four weaponisation effort.
910923	UNSC calls on Iraq to implement UNSCR 707 (1991).	
910924	UNSC condemns Iraq for obstruction of IAEA 6.	
911011	UNSCR 715 (1991) adopted.	Approves OMV Plan called for in UNSCR 687 (1991).
911011 911022	IAEA 7.	Destruction of uranium enrichment and reprocessing equipment.
911111 911118	IAEA 8.	Removal of unirradiated fuel. Centrifuge program investigation.
911119	Iraq rejects OMV Plan.	Iraq refused to accept UNSCR 715 (1991) until 931126.

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911120	Iraq provides information relevant to OMV.	Iraq provided supplementary declaration on 920113-14, but declaration remained incomplete.
911211	Iraq provides IAEA with information regarding nuclear programs.	Information required for OMV under UNSCR 715 (1991).

1992

920111 920114	IAEA 9.	Iraq acknowledges centrifuge program procurement not previously declared.
920127 920130	Special UNSCOM Mission.	To secure unconditional acceptance of UNSC resolutions.
920205 920213	IAEA 10.	Search for reported underground reactor finds no evidence of such a facility.
920219	UNSC declares Iraq in material breach of UNSCR 687 provisions.	Failure to acknowledge obligations under UNSCR 707 & 715. Failure to provide full disclosure of weapons capabilities.
920221 920223	Special UNSCOM Mission.	To secure unconditional acceptance of obligations under UNSC resolutions.
920227	UNSCOM reports failure of Special Mission	Iraq does not accept unconditionally its obligations under UNSC resolutions.
920312	Iraq hands over FFCD to IAEA Director General.	FFCD consolidates previous declarations and is treated as a draft in light of Agency questions about its adequacy.
920407 920415	IAEA 11.	Al Atheer-Al Hatteen facility destruction begun.
920526 920604	IAEA 12.	Al Atheer facility destruction continued. Removal of HEU from Iraq.
920714 920721	IAEA 13.	Tarmiya and Al Sharqat facility destruction largely completed.
920831 920907	IAEA 14.	Baseline radiometric survey of major Iraqi watercourses started.
920925	IAEA General Conference condemns Iraq's non-compliance with safeguards agreement.	
921108 921118	IAEA 15.	Baseline radiometric survey of major Iraqi watercourses completed.
921205 921208	IAEA 16.	Iraq resists providing procurement information.

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1993

930125 930131	IAEA 17.	Continued Iraqi resistance to providing procurement information.
930303 930311	IAEA 18.	Search reveals no evidence of reported underground facilities.
930430 930507	IAEA 19.	First periodic radiometric survey of major Iraqi watercourses.
930625 930630	IAEA 20.	Preparations for removal of irradiated fuel.
930724 930727	IAEA 21	Continuation of IAEA 20 activities. First inspection of south Taji area.
930831 930909	High Level Technical Talks (HLTT) in New York.	UNSCOM, IAEA, and Iraq participate.
930910 930924	IAEA Aerial Gamma Survey.	Tuwaitha, Al Jesira, & Al Atheer surveyed.
930930 931008	IAEA/Iraq High Level Technical Talks in Baghdad.	IAEA and Iraq review progress in implementing UNSCR 687 and 715.
931002 931008	High Level Technical Talks in New York.	Follow up of first talks between IAEA, UNSCOM & Iraq in 9308.
931101 931115	IAEA 22.	Second periodic radiometric survey of major Iraqi watercourses.
931115 931130	High Level Technical Talks in New York.	Third round of talks to address outstanding issues. IAEA, UNSCOM & Iraq participate.
931126	Iraq accepts its obligations under UNSCR 715 (1991).	UNSCR 715 (1991) approved OMV plan on 911011.
931202 931216	IAEA Aerial Gamma Survey follow up.	Follow up of 930910-24 aerial survey.

1994

940202 940205	High Level Technical Talks in Baghdad.	Fourth round of talks between IAEA, UNSCOM & Iraq.
940204 940211	IAEA 23.	Machine tool inventory and machine tool surveillance system installation. Removal of irradiated fuel completed.
940314 940319	High Level Technical Talks in New York.	Fifth round of talks between IAEA, UNSCOM & Iraq.
940411 940422	IAEA 24.	Third periodic radiometric survey of major Iraqi watercourses.
940424 940426	High Level Technical Talks in Baghdad.	UNSCOM, IAEA, & Iraq assess progress in preparing for OMV and issue joint statement.

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940622 940701	IAEA 25.	Continuing work to establish nuclear material balance.
940704 940705	High Level Technical Talks in Baghdad.	Sixth round of talks between IAEA, UNSCOM & Iraq.
940822	IAEA 26.	Laser uranium enrichment investigation.
940907	NMG 9401.	Continuous permanent presence of IAEA in Iraq (Nuclear Monitoring Group (NMG)) established.
941014 941021	IAEA 27.	Fourth periodic radiometric survey of major Iraqi watercourses.
1995		
950414	UNSCR 986 (1994) adopted.	Authorises sale of Iraqi oil for humanitarian needs. Negotiations for implementation delay start of oil sale until 1997.
950404 950412	NMG 9504.	Fifth periodic radiometric survey of major Iraqi watercourses.
950807	Lt. Gen. Hussein Kamel defects to Jordan.	
950812	Iraq invites IAEA to send delegation to Baghdad.	
950817 950820	IAEA High Level Delegation in Iraq.	Revelations confirming extensive clandestine nuclear weapons program indicate need for complete revision of FFCD.
950817	Iraq admits having planned to use safeguarded HEU for weapon.	Crash Program designed to overcome lack of fissile material production.
950820	Iraq hands over document cache to UNSCOM & IAEA.	Iraq releases information allegedly withheld on Hussein Kamel's orders without the knowledge of the Iraqi government. Haider House Farm cache consists of more than 500,000 pages of documents.
950822	IAEA discussions with Hussein Kamel in Jordan.	
950909 950920	IAEA 28.	Follow up investigation of information provided after Hussein Kamel's defection. Need for new FFCD restated.
951015 951022	NMG 9515.	Sixth periodic radiometric survey of major Iraqi watercourses.
951017 951024	IAEA 29.	Further follow up of information provided after Hussein Kamel's defection.

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1996

960301	Iraq delivers FFCD.	IAEA review establishes need for clarifications and additions to FFCD.
960326	UNSCR 1051 (1996) adopted.	Established import/export monitoring mechanism.
960422 960429	NMG 9605.	Seventh periodic radiometric survey of major Iraqi watercourses.
960513 960519	IAEA 30.1.	Ad hoc mission to clarify FFCD. Resulted in more than 300 requests for substantive revisions.
960523 960524	IAEA requests 50 EMIS-related changes to FFCD.	
960617 960708	High Level Technical Talks in Baghdad. IAEA 30.2.	Ad hoc mission to clarify FFCD.
960620	Iraq delivers revised FFCD (FFCD (F-1)) to IAEA 30.2 mission.	
960907	Iraq delivers what it asserts is final FFCD (FFCD-F).	FFCD-F incorporated clarifications from IAEA 30.1 and 30.2 missions. Agency review establishes need for clarifications of FFCD-F.
961015 961023	NMG 9614.	Eighth periodic radiometric survey of major Iraqi watercourses.
961112 961115	NMG 9616 Underwater Search Campaign.	Search finds no evidence of reported dumping of nuclear waste in Lake Razzaza.

1997

970203 970210	IAEA 30.3 in conjunction with NMG 9702.	Ad hoc mission to clarify FFCD-F. Additional clarifications requested.
970301 970310	NMG 9703 Sub-Surface Search Campaign.	Search of declared burial sites to verify independently Iraqi claims of post-war destruction and concealment.
970307	IAEA Director General meets Iraq's Foreign Minister.	Requirement to reaffirm unconditionally Iraq's obligations under Non-proliferation Treaty and Safeguards Agreement.
970411 970421	NMG 9705.	Ninth periodic radiometric survey of major Iraqi watercourses.
970501	Iraq's Foreign Minister unconditionally reaffirms Iraq's obligations under NPT and Safeguards in letter to IAEA Director General.	Response to meeting with IAEA Director General on 970307.
970516 970521	IAEA 30.4.	Ad hoc mission to further clarify FFCD-F. Additional clarifications requested.

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970514 970531	NMG 9709 Aerial Gamma Survey.	20 sites mapped in detail.
970719 970724	IAEA 30.5.	Ad hoc mission to further clarify FFCD-F. Additional clarifications requested to FFCD-F and 15 technical matters.
970801	IAEA informs Iraq of need for additional information in five areas.	Follow up of IAEA 30.5.
970804 970916	Series of 24 letters received from Iraq in response to matters arising from IAEA-30.5.	Iraq provides incomplete response to questions about the role of the Governmental Committee and foreign assistance to its clandestine nuclear programme. Iraq maintains that it has no knowledge of the late Lt.Gen. Hussein Kamel's motives in concealing materials and documentation and declines to include summary of achievements in FFCD-F.

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Attachment 3. Destruction, removal and rendering harmless

3.1. Main equipment and materials used in Iraq's clandestine nuclear programme which were destroyed or rendered harmless under IAEA supervision

Time Period	Programme Activity	Equipment Location	Main Components	Destruction Method	Total Quantity
October - November 1991, IAEA-7/8	Gas centrifuge enrichment	Engineering Design Centre, Al Furat Centrifuge Production Facility	All detected centrifuge components and important related equipment were either removed by the Inspection teams, rendered harmless or destroyed, including: Centrifuge housings, aluminium rotor tubes, carbon fibre cylinders, complete rotor assemblies, unfinished maraging steel cylinders, molecular pumps, motor stators, bearings, frequency converters, balancing machines, centrifuge test jigs, complete oil centrifuges, oil centrifuge cylinders, centrifuge jackets, UF6 feeding system, miscellaneous parts of the machine tools, AlNiCo and SmCo ring magnets, jig for MIG welder, mandrel for flow forming machine, electron beam welder fixture, rotating spindle and mandrel for CNC machine tool, special collet and whirling head, specific fixtures for centrifuge production.	Mainly by crushing or flame cutting.	More than 1790 components and items.
	Electromagnetic Isotope Separation (EMIS)	Tarmiya EMIS Facility, Tuwaitha Nuclear Research Centre, Daura (SEHEE), Amin (Um Al Maarik)	Vacuum chambers, coils, collectors, injector power supply, ion sources, iron systems, poles, coil-winding machines, and elements of machine tools.	Mainly by flame cutting.	More than 340 items.
	Reprocessing	Tuwaitha Nuclear Research Centre	Chopping machine, glove boxes, manipulators, cables for manipulators, mixer settlers, hot cells, dissolver.	The glove boxes were filled with cement. Mixer settlers were filled with epoxy resin. Hot cells, dissolver and chopping machine were rendered harmless by cutting and removal of manipulators.	More than 40 items.
	Chemical isotope separation	Tuwaitha Nuclear Research Centre	Glass columns (10) and other items used in the chemical separation work.	Smashed.	More than 10 items.
January 1992, IAEA-9	Gas centrifuge enrichment	Engineering Design Centre, Al Furat Centrifuge Production Facility	Aluminium alloys in the form of tube extrusions (more than 500 tonnes), ferrite magnets, aluminium upper flange forgings (9,000), aluminium jacket ring forgings (9,000), bottom flanges (250).	Melting and mixing with lower grade materials. Ferrite magnets were destroyed by crushing.	More than 500 tonnes of materials.

Time Period	Programme Activity	Equipment Location	Main Components	Destruction Method	Total Quantity
April - May 1992, IAEA-11/12	Weaponisation	Al Atheer Centre	Cold and hot isostatic presses, furnaces, plasma spray systems, machine tools, vacuum pumps, power supplies.	Flame cutting; demolition with explosives.	More than 50 items.
April and November 1992, IAEA-11/15	EMIS	Tarmiya EMIS Facility, Tuwaitha Nuclear Research Centre	Experimental EMIS magnet system with 9 double poles, coil winding machines and their accessories, HEPA filter elements and exhaust air filtration units.	Mainly by flame cutting. Filtration components were crushed.	More than 10 items and 285 filter elements and units.
November 1992, IAEA-15	Gas centrifuge enrichment	Engineering Design Centre	350-grade maraging steel rods and cylinders unilaterally destroyed by Iraq (76 t) were further adulterated by re-melting and diluting it with equal amounts of high carbon steel in Basra Foundry.	Melting and mixing with lower grade materials.	About 76 tonnes of maraging steel.

Note: Many items of the equipment used in the Iraq's clandestine nuclear programme were destroyed in the aerial bombardment (January-February 1991) and were confirmed by the IAEA as not recoverable or rendered harmless.

3.2. Main equipment and materials used in Iraq's clandestine nuclear programme removed by IAEA

Time Period	Programme Activity	Equipment Location	Main Components	Total Quantity
From October 1991 to April 1992, IAEA-7/8/9/11	Gas centrifuge enrichment, weaponisation, radiochemistry	Tuwaitha Nuclear Research Centre, Engineering Design Centre, Al Atheer Centre	Examples of major centrifuge components (rotor tubes, end caps, pin bearings, etc.), centrifuge rotors, HEPA air filters, computer codes, high-speed streak video cameras and their components, holding collar for the mandrel, beryllium metal, flow-forming roller, die used to manufacture the explosive lenses, parts of the CNC co-ordinate measurement machine.	More than 200 items.
Removal of the items after the departure from Iraq of the late Lt. General Hussein Kamel				
From September 1995 to July 1997, IAEA-28/29/30.5	Gas centrifugo enrichment, weaponisation	Tuwaitha Nuclear Research Centre, Engineering Design Centre, Al Atheer Centre, Al Qa Qaa GE	AlNiCo and CoSm ring magnets, maraging steel (17 tonnes), spools of high modulus and high tensile strength carbon fibres, cylindrical initiator, thermal batteries, wave front shape measurement device, tape with back-up of the computer codes, 32-point electrical distributor for firing set, detonators and ionisation probes, krytrons, 8-channel ionisation probe analyser.	More than 20 items and more than 200 ring magnets.

3.3. Main buildings of the sites directly involved in Iraq's clandestine nuclear programme destroyed under IAEA supervision

Destruction Date	Site	Destroyed Buildings	Destruction Method
April-May 1992, IAEA-11/12	Al Atheer Centre	- Carbide (uranium machining), Bld. 55 - Casting (uranium metallurgy), Bld. 50 - Quality Control, Bld. 19 - Explosion Chamber, Bld. 18 (cutting with torches) - High Explosives Test Bunker, Bld. 33 - Physics (gas gun), Bld. 21 - Polymer (uranium metal processing), Bld. 84 - Powder Preparation, Bld. 82	Demolition with explosives. Bld. 33 was filled with concrete and scrap metal, the protective berm has been removed.
July-September 1992, IAEA-13/14	Tarmiya EMIS Facility	- Electrical Sub-Stations, Blds. 5, 38, 243 - EMIS Beta Separator Building, Bld. 245	Demolition with explosives/heavy machinery.
July-September 1992, IAEA-13/14	Al Sharqat EMIS Facility	- Electrical Sub-Stations, Blds. B-20, B-27, B-29 - EMIS Beta separator building, Bld. B-21	Demolition with explosives/heavy machinery.
November 1993, IAEA-22	Abu Skhair Mine	Abu Skhair uranium mine	Backfilled, shaft door welded and sealed.

Note: Electrical power supplies to the Tarmiya and Al Sharqat sites were reduced by an order of magnitude.

3.4. Main buildings of the sites directly involved in Iraq's clandestine nuclear programme destroyed in the aerial bombardment
(January-February 1991)

Site	Buildings Destroyed
Tuwaitha Nuclear Research Centre	- Radiochemistry Laboratories (Bld. 9)[3] - Physics Department (Bld. 10B) [3] - Laboratory for Uranium Metal Preparation (Bld. 10) [1, 3] - IRT-5000 Reactor (Bld. 13) - Computer Hall and Offices (Bld. 13 part) - Electrical Sub-Stations (Blds. 14, 72, 84) - Radioisotope Production Department (Bld. 15A) [1] - Quality Control of Radioisotope Production Department (Bld. 15B) [1, 3] - LAMA Laboratories (Reprocessing), Bld. 22) [3] - Experimental Workshop, Laser and Plasma Studies (Bld. 23) [1] - Tammuz-2 Reactor (Bld. 24) - Store and Workshop Bld. 26) - Decontamination Laboratory (Bld. 27) - Chemical Coating Laboratory (Bld .30) - Cooling Tower for Tammuz-2 Reactor (Bld. 31) - Radioactive Waste Treatment Station (RWTS, Bld. 35) - Calibration Laboratories and Decontamination Area (Bld. 41) - Laboratories for Material Processing (Bld. 63) - Laboratories for Uranium Treatment and Liquid Radioactive Waste (Bld 64) [3] - Laboratories for Experimental Physics and Measurements (Bld. 68) - Hydrogen Station (Bld. 70) - Sewage Station for 30-July Project (Bld. 71) - Experimental Research Laboratories for Fuel Fabrication (Bld. 73 complex) [1] - Cooling Tower of Bld. 80 (Bld 79) - Laboratories for EMIS Development, (Bld. 80) [1, 3] - Laboratories for UCl_4 Preparation and Purification (Bld. 85)[1, 3] - Chemical Enrichment Laboratories (Bld. 90)
Al Atheer Centre	- High Explosives Test Bunker and stores (Bld. 33)[2] - Offices of Activity 40B (Bld. 79) - Electrical Laboratories (Bld. 94)
Tarmiya EMIS Facility	- EMIS Alpha Separator Building (Bld. 33) - Air Conditioning Units (Blds. 21-23, 34-36, 244, 246) - EMIS Beta Separator Building (Bld. 245) - Electrical Power Sub-Stations (Blds. 5, 38, 61, 243, 228)[2] - EMIS Separator Wash Room (Bld. 225)[2] - Waste Treatment Building (Bld. 216)
Shargat EMIS Facility	- EMIS Washing and Cleaning (Bld. C-034) - EMIS Washing (C-054) - Electrical Power Supply (Blds. B-029, B-027, B-020, B-032)[2] - Utility Building (Bld. B-031) - Cooling Towers (Bld. B-033) - Equipment Hall (Bld. B-051) - Main Power Station (B-046) - EMIS Beta Separator Hall (B-021)[2] - Workshop (B-003)
Al Qaim Uranium Purification Facility	- Uranium Purification Building (Bld. 300)
Jesira Uranium Processing Plant	- UO_2 Production Plant[1] - UCl_4 Production Plant - UCl_4 Production Plant Utilities - UO_2 Production Plant Utilities

[1] Iraq further levelled building to the ground for concealment of actual activities (Iraq's declaration).
[2] Building further destroyed under IAEA supervision.
[3] Building decontaminated by Iraq after the war to conceal previous activities (Iraq's declaration).

3.5. Uranium fuel removed from Iraq under IAEA supervision

No.	Date of Removal	Element Weight (g)	U-235 Weight (g)	No of Items	Uranium Enrichment (%)	Irrad. Status
1.	1991-11-17	13722	10998	68	80	Fresh
2.	1991-11-17	3538	1272	10	36	Fresh
3.	1993-12-04	86480	8648	68	10	Irrad.
4.	1993-12-04	1002	360	3	36	Irrad.
5.	1993-12-04	8150	6588	41	80	Irrad.
6.	1994-02-12	1280	128	1	10	Irrad.
7.	1994-02-12	11041	8872	55	80	Irrad.
8.	1994-02-12	11874	11050	38	93	Irrad.
9.	1994-02-12	7900	55	2	Natural	Irrad.
	Total:	**144987**	**47971**	**286**		

Notes: 1. Uranium fuel was transferred to Russia for processing.
2. In November 1991 IAEA also removed 63 mg of U-233.
3. Uranium fresh fuel components of 323 g (36% enrichment) exempted by Iraq from safeguards and 417 g (93% enrichment) were transferred to the IAEA Seibersdorf Laboratory.

3.6. Plutonium removed from Iraq under IAEA supervision

No	Date	Weight	Plutonium Isotope	No. of Items	Origin
1.	June 1991 IAEA-2	< 5 g	Pu		Iraq
2.	October 1991 IAEA-7	Microgram quantities	Pu-238	2 items	Iraq
3.	November 1991 IAEA-8	Milligram quantities	Pu-239	6 sealed ampoules	Amersham, UK
4.	November 1991 IAEA-8	Microgram quantities	Pu-238	33 sealed ampoules	Amersham, UK
5.	November 1991 IAEA-8	< 0.3 g	Pu		Iraq

Note: 1. Plutonium was transferred to the IAEA Seibersdorf Laboratory.
2. Two Np-237 standards (about 200 mg) were also removed by IAEA (November 1991).
3. Imported Pu-Be source containing about 16 g of Pu has not been located by Iraq.

Attachment 4. Summary of IAEA inspection campaigns

Inspection Number	IAEA-01/02	Activities
Chief Inspector	Perricos	The principal activities of both IAEA-01 and IAEA-02 were, firstly, the verification of the accuracy and completeness of the Iraqi declarations submitted under the requirements of Security Council resolution 687, mainly concerned with material and activities at Al Tuwaitha. Secondly, to conduct inspections of sites designated by the Special Commission established under resolution 687 where there were grounds to believe that undeclared nuclear activities had been conducted or that undeclared equipment might be stored, and third, to develop an overall picture of the nature, objectives and capabilities of the Iraqi nuclear programme. **Inspections at Tuwaitha showed that generally the facilities where significant activities may have taken place were thoroughly destroyed**, in many cases by bombing during the Gulf War but in others by extensive clearing operations by the Iraqis after the war. **Both research reactors (TAMUZ 1 and 2) were heavily damaged, in the case of TAMUZ 1 in 1981 by the Israeli attack. The building housing the IRT-5000 reactor was heavily damaged, but the pool with the reactor fuel and storage racks was still intact.** Smear tests and samples were taken of equipment and surrounding areas. Other Matters - Confirmation of recovered Plutonium - Presence of safeguarded HEU verified - Extensive concealment activities noted
Inspection period:	15-May-91	
	21-May-91	
Inspection days	6	
Inspection personnel	34	
Person days	204	
Facilities inspected	7	
Inspection Number	IAEA-02	At two sites designated for inspection by UNSCOM the Iraqis denied the right of access for the purposes of inspection and removed materials even after the Chief Inspector had ordered that no such movement should take place until after the inspection. Photographic evidence substantiated a strong case that the material moved was related to undeclared uranium enrichment activities. The matter was immediately brought to the attention of the Security Council and a high level mission comprising the IAEA Director General, the Chairman of the UN Special Commission and the UN Under Secretary General for Disarmament Affairs was despatched to Iraq to resolve the situation. As a result of this mission Iraq pledged itself to grant immediate and unimpeded access to inspection sites and indicated its intention to submit an additional list of nuclear items relevant to Security Council resolution 687 (1991). Other Matters - Conclusion that an undeclared enrichment program via EMIS existed
Chief Inspector	Zifferero/Kay	
Inspection period: from	22-Jun-91	
to	03-Jul-91	
Inspection days	11	
Inspection personnel	18	
Person days	198	
Facilities inspected	7	

Note. Bold text indicates destruction, removal and rendering harmless activities.

Attachment 4 (continued)

Inspection Number	IAEA-03	Activities
Chief Inspector	Perricos	The principal activity was the investigation, through both inspection and discussions, of Iraq's declaration of its enrichment programme, made on the eve of the team's arrival in Baghdad. The Iraqis were cooperative and provided many clarifications about the declared enrichment programme, but the team considered it likely that the full extent of the centrifuge enrichment programme remained to be disclosed. The declared extent of the centrifuge enrichment programme could not be verified during this mission. A large number of samples was collected, as were numerous documents, both given by Iraq and collected by the team during inspection of various sites. The role of Tarmiya as the main production site for the enrichment of uranium by the EMIS method was confirmed, as was the fact that Al Sharqat was built as a replica of Tarmiya. Iraq declared milligram quantities of uranium enriched up to levels of 40-45% at Tuwaitha, and up to 10% at Tarmiya, giving a total of 0.6 kilograms with an average enrichment of 4%. The Iraqis stated that the Research Centre at Tuwaitha was the site of all research and development work on uranium enrichment, including EMIS, centrifuge enrichment and chemical enrichment. Throughout this inspection, no access problems were encountered. Other Matters - New declaration of nuclear material holdings and programs - Denial of any nuclear weapon development work - Declaration of Al Qaim yellowcake production - Declaration of production of milligram quantities of HEU
Inspection period: from	07-Jul-91	
to	19-Jul-91	
Inspection days	11	
Inspection personnel	37	
Person days	407	
Facilities inspected	15	

Attachment 4 (continued)

Inspection Number	IAEA-04	Activities
Chief Inspector	Kay	Iraq presented the team with a list of nuclear materials containing items previously not declared. It confirmed the existence of a clandestine programme to manufacture several kilograms of uranium oxide fuel, irradiate this in the IRT-5000 reactor and reprocess the irradiated fuel in order to chemically separate gram amounts of plutonium. A detailed assessment of the EMIS programme was carried out, and it was clear that this approach had been given priority and the project was fast paced and moving toward industrial-scale production at the Tarmiya establishment. The capacity of local industries to produce process equipment, components and feed material appeared to be consistent with their declared contribution to the EMIS programme. Additionally, a more comprehensive picture of the centrifuge enrichment programme was obtained, particularly with regard to machine component manufacturing, system (cascade) design and UF6 feed preparation. Extensive inspection work was undertaken at the Al Jesira chemical production facility, the intended site for the production of UF6 to feed the centrifuge enrichment project. Verification of the existence of activities relevant to both the research and development and to the manufacturing and testing required in order to convert fissile material into a nuclear weapon were carried out. Extensive information in response to intense questioning was gathered, and a large number of documents in the form of reports, detailed fabrication drawings and computer printout records of laboratory experiments were obtained. The attitude of the Iraqi side continued to be as cooperative as shown during the third inspection. Reticence was, however, noted as regards the disclosure of the procurement sources of equipment and material relevant to the centrifuge project. Deceptive behaviour was admitted to in at least one instance during the third mission. Other Matters - Provision of detailed planning, procurement and design information re EMIS - Thorough analysis of Tarmiya site in response to new disclosures
Inspection period: from	27-Jul-91	
to	10-Aug-91	
Inspection days	14	
Inspection personnel	20	
Person days	280	
Facilities inspected	22	

Attachment 4 (continued)

Inspection Number	IAEA-05	Activities
Chief Inspector	Thorne	The principal activities were to carry out routine work necessary as a follow up to previous inspections. Included in this was the verification of all seals on nuclear material and hot cells and an attempt to verify the inventory of nuclear material previously collected into storage locations in Tuwaitha and placed under seal, a task made difficult due to operator bookwork/labelling errors. The IRT 5000-reactor fuel was inspected and NDA measurements performed in order to determine the history of the irradiated fuel, with the exception of a few fuel assemblies that were inaccessible. Additionally, arrangements for the removal of the clandestinely produced plutonium were discussed with the counterpart and the material packaged and prepared for transport to IAEA HQ. A preliminary investigation into the quantity and location of heavy water was undertaken. Iraq explained that **all heavy water was lost during the bombing of the reactors during the Gulf war**. A storage tank was seen by the inspection team, and it showed damage consistent with Iraq's claim. Formal meetings with the Iraqi counterpart were undertaken to investigate the extent of the chemical enrichment programme, followed by inspections at relevant facilities. The opinion of the inspection team was that a far from complete disclosure had been made in this area. Other Matters - Removal of 4.868 grams Plutonium leaving only 0.0274 grams in Iraq - Discovery that two Soviet IRT-5000 fuel elements had end plates cut off - Difficulty in establishing a reliable inventory of nuclear material, 115 samples taken - Iraq starts to remove damaged buildings at Tuwaitha - Additional nuclear material declared, verification attempts continue
Inspection period: from	14-Sep-91	
to	20-Sep-91	
Inspection days	6	
Inspection personnel	15	
Person days	90	
Facilities inspected	3	

Attachment 4 (continued)

Inspection Number	IAEA-06	Activities
Chief Inspector	Kay	The principal activities were the search for and removal of documentation associated with Iraq's weaponisation activities. Inspections of the Nuclear Design Centre and the headquarters of the Petrochemical Three (PC-3) program, along with other facilities were carried out resulting in the seizure by the inspection teams of a number of documents showing that Iraq had a program for the development of an implosion-type nuclear weapon, the design work of which was conducted at the Al Atheer facility. These documents also showed that Iraq's Ministry of Industry and Military Industrialisation, the Iraqi Atomic Energy Commission (IAEC) and Iraq's Ministry of Defence were all linked to this programme. Contrary to Iraq's claims of having only a peaceful nuclear programme, the team found documents showing that Iraq had been working on a nuclear weapons design and one document linking the IAEC to work on a surface to surface missile project. Other documents contained evidence that since 1981 Iraq intended to produce enriched uranium by methods other than EMIS, specifically that gaseous diffusion and centrifuge enrichment techniques were being explored. Documents showing the development of a covert procurement system of nuclear weapons related equipment from foreign sources were seen by the inspection teams. During the course of this inspection the team was detained by the Iraqis for 5 hours at the first inspection site, whereupon all documents collected by the team were confiscated. Iraq interrupted the inspection of the second site and detained the inspection team for 96 hours in an adjacent parking lot. Iraq also opened official mail addressed to the Chief inspector and the UNSCOM representative. Other Matters - Revelation of existence of a covert nuclear weapons project code-named Petrochemical Three (PC-3) - Basic design of Iraqi nuclear weapon revised 5 times as of June 1990 - Revelation of substantial covert foreign procurement network for weapons related needs - Conclusion that there was repeated and wilful non-compliance with SCR 687 and 707 and violation of UN/IAEA privileges and immunities
Inspection period: from	22-Sep-91	
to	30-Sep-91	
Inspection days	8	
Inspection personnel	44	
Person days	352	
Facilities inspected	6	

Attachment 4 (continued)

Inspection Number	IAEA-07	Activities
Chief Inspector	Perricos	Further investigation into the weaponisation activities was carried out, following Iraq's acknowledgement that basic computations and high explosive testing for weapon component development had been carried out. Al Atheer facility was identified by the inspection team as the prime development and testing site, with the facilities at Al QaQaa and Al Hatteen High Explosive Site contributing. The Iraqis admitted that Al Atheer had a role in the weaponisation programme. Additionally, investigation of the centrifuge and the gaseous diffusion enrichment programmes continued. The Iraqis admitted to a feasibility study into the gaseous diffusion method during 1982 to 1987, which included laboratory work on diffusion barriers, but the programme was phased out. **Destruction or rendering harmless of centrifuge and EMIS components was started, along with identification and tagging of associated manufacturing equipment for future such action. Hot cells and associated glove boxes used in the clandestine production of plutonium were rendered harmless. Further activities were undertaken with regard to the NDA measurements of the IRT-5000 irradiated fuel to determine its integrity and verify Iraq's statements regarding the extent of irradiation the assemblies were subjected to.** Activities with regard to the transport out of Iraq of the fresh fuel, and compilation of an inventory of nuclear material accumulated at storage Location C at the Tuwaitha facility were also carried out. A feature of this inspection was the large amount of correspondence between the Chief Inspector and the Iraqi counterpart, in order to unequivocally establish the Iraqi answers to key questions, as oral questioning was proving insufficient for obtaining definitive statements. Other Matters - Provision of list of facilities involved in enrichment and weaponisation program - Iraq partially acknowledges role of Al Atheer and discovery of extensive metallurgical equipment - Weaponisation information provided - Denial of pursuit of uranium enrichment via laser isotope separation - Verification of nuclear material continues
Inspection period: from	11-Oct-91	
to	22-Oct-91	
Inspection days	11	
Inspection personnel	39	
Person days	429	
Facilities inspected	18	

Attachment 4 (continued)

Inspection Number	IAEA-08	Activities
Chief Inspector	Perricos	In field activities related to information on the procurement of equipment essential to Iraq's clandestine nuclear programme continued despite persistent efforts by Iraq to conceal such information. Further investigations with regard to weaponisation activities were carried out, particularly in the area of the initiator design and testing and work on flash X-ray systems. Answers given were vague and general, particularly with regard to questions derived from the secret PC-3 progress reports obtained during IAEA-06. **Systematic destruction of the EMIS double-pole magnets was started, along with the destruction/rendering harmless of basic equipment related to the EMIS and other enrichment programmes. Two high-speed streak video camera systems were removed from Iraq to the IAEA in Vienna. All fresh highly enriched uranium of Soviet origin was shipped** apart from about 400g of 93% unirradiated enriched uranium. The irradiated fuel elements of French and Soviet origin still remained in Iraq. Verification of nuclear material at Location C, Tuwaitha, was completed, with only a few outstanding questions remaining to be answered by Iraq. 16.7 tons of uranium in waste in the Mosul area remained to be properly verified. Monitoring activities initiated during the previous mission were continued. Other Matters - Acknowledgement of political decision to prevent disclosure of procurement network - Most manufacturers of centrifuge related equipment identified - Destruction of centrifuge, EMIS and reprocessing equipment continued - Nuclear material inventory verified by statistical methods - Permission given to demolish Tuwaitha buildings 9, 15, 15A, 55, 60, 64, 72, 73 and 74
Inspection period: from	11-Nov-91	
to	18-Nov-91	
Inspection days	7	
Inspection personnel	19	
Person days	133	
Facilities inspected	10	

Inspection Number	IAEA-09	Activities
Chief Inspector	Zifferero	Discussions were held with senior Iraqi officials regarding the procurement of large quantities of stock materials and components needed in the production of gas centrifuge machines, previously not included in any Iraqi declaration. **Acknowledgement of the procurement of 100 tons of maraging steel needed for producing centrifuge rotors and internal fittings, and of several thousands of aluminium forgings needed for the vacuum housing flanges was made by the Iraqi side, who stated that all had been destroyed or rendered harmless by melting and crushing before the beginning of nuclear inspections in Iraq under resolution 687.** Verification and sampling of the **melted maraging steel** and **crushed ferrite magnets** was undertaken. Rough in-field estimates of the quantities on site appeared consistent with the quantities procured. Inconsistencies regarding the Iraqi centrifuge programme remaining from previous inspections were resolved, leading the inspection team to the opinion that Iraq had not reached the point where it would have been able to start centrifuge production on a sizeable scale, but given time, it would have been successful. However, the centrifuge enrichment programme had reached a point where the materials necessary for certain key centrifuge components had been identified, and these materials were being procured as opportunities presented themselves, even though the final design had not been fixed nor the manufacturing process fully implemented. Other Matters - German Government reports Iraqi procurement of large quantities of materials and components for centrifuge - Re-inspection of Rasdhiya (Engineering Design Centre) but Iraqi deception and concealment activities continue
Inspection period: from	11-Jan-92	
to	14-Jan-92	
Inspection days	3	
Inspection personnel	14	
Person days	42	
Facilities inspected	5	

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Attachment 4 (continued)

Inspection Number	IAEA-10	Activities
Chief Inspector	Zifferero	Inspection of the SAAD-13 State Establishment, indicated by the Special Commission as a site where an underground nuclear reactor intended for significant plutonium production may have been located was a main priority of this mission. No underground facility of any kind was found. Inspections at other designated sites were carried, as were a number of follow up actions from previous inspection missions. Nuclear material accounting work continued, with a view to reconciling IAEA findings and Iraqi declarations. The steady improvement in Iraqi cooperation with the Inspection teams, started during the seventh mission, continued throughout this mission. The Iraqi side declared that the reason for this enhanced cooperation was their wish to accelerate and conclude, to the IAEA's satisfaction, the activities under SCR 687 and proceed as soon as possible to the OMV phase. Iraq maintained that, with the exception of procurement, the IAEA had discovered almost all there was to know about the principal objectives, achievements and installations of their nuclear programme, and if information was missing, it related only to details. Other Matters - Agreement to clarify nuclear material declaration with a revised declaration - Meetings with Iraqi authorities to clarify their position regarding non-compliance with their obligations to provide information for ongoing monitoring and verification pursuant to SCR 715
Inspection period: from	05-Feb-92	
to	13-Feb-92	
Inspection days	8	
Inspection personnel	31	
Person days	248	
Facilities inspected	19	

Inspection Number	IAEA-11	Activities
Chief Inspector	Perricos	**Destruction of key technical installations comprising buildings and equipment at the Al Atheer-Al Hatteen site were initiated during this mission. Some 24000 m2 of the designated 35 000 m2 of surface of buildings were destroyed as was most of the equipment.** Transfer of irradiated fuel into new storage tanks located above ground was carried out at Location B, in order to prevent deterioration of the fuel due to flooding by rainwater or groundwater. Further meetings were held with regard to nuclear material accountancy, resulting in new information on quantities and flows of material. Investigations continued into the foreign procurement of maraging steel and carbon fibre rotors, and into the weapons development programme, but with no success. It was clear that a governmental decision not to declare this information had been taken. Previously inspected sites were revisited to continue the inventory and manufacturer identification of equipment and machine tools capable of use in the Iraqi nuclear programme. During this mission discussions were held on a draft report entitled "The Iraqi Nuclear Program Before and After Security Council Resolution 687 (1991)". This report is intended to be the "Full, Final and Complete" declaration (FFCD) of Iraq's nuclear programme. Other Matters - 8 buildings and 29 equipment items at Al Atheer designated for destruction - New declaration of nuclear material flow and production. IAEA's assessment changes substantially - Additional information requested in FFCD
Inspection period: from	07-Apr-92	
to	15-Apr-92	
Inspection days	8	
Inspection personnel	26	
Person days	208	
Facilities inspected	17	

Attachment 4 (continued)

Inspection Number	IAEA-12	Activities
Chief Inspector	Perricos	**Destruction of key technical buildings and equipment at Al Atheer-Al Hatteen site was completed. Preparations for destruction of selected buildings at Tarmiya and Al Sharqat were initiated** under the supervision of the inspection team. Further attempts to obtain information regarding the procurement of the maraging steel, carbon fibre rotors and technical advice regarding centrifuge technology proved fruitless as Iraq had taken a governmental decision not to provide specific information on suppliers. Identification of machine tools and equipment used in the nuclear programme for the purposes of future monitoring was completed. **The final quantity of fresh highly enriched uranium fuel (about 400 g) was removed from Iraq.** Clarifications both through discussions and written correspondence of several issues related to Iraq's work on weaponisation and uranium enrichment were obtained. Iraqi cooperation in implementing the destruction plans could not be faulted. However, in the course of this mission definite stiffening in Iraq's working relationship with the inspection team was noted. Numerous attempts to prevent or limit the taking of photographs and placement of seals were made. The Iraqi explanation was that previous active cooperation had not resulted in an improvement in the sanctions situation. Other Matters - Final version of FFCD provided on June 4 - Iraq states that it considers the nuclear material file to be closed and indicates unwillingness to discuss it further - Declaration that all undeclared nuclear material processing in Building 73 complex was done in Building 73C, except for 59 kg processed in the safeguarded Buildings 73A and 73B - Iraq takes position that the enrichment program has been fully disclosed - Daily production records for Al Qaim provided
Inspection period: from	26-May-92	
to	04-Jun-92	
Inspection days	9	
Inspection personnel	27	
Person days	243	
Facilities inspected	23	

Inspection Number	IAEA-13	Activities
Chief Inspector	Hooper	**Destruction of buildings at Tarmiya and Al Sharqat, started in the previous mission, was largely completed. Maraging steel (approximately 100 tonnes) stored at Iskanderiya facility were identified and photographed to aid subsequent transportation to a foundry in Basra for rendering harmless.** Additional technical data and contract numbers to aid in the identification of manufacturers/procurement routes for critical equipment were collected. Monitoring activities at a number of sites were carried out to verify seals and check on requested movement of equipment. An English language version of the Full, Final and Complete Declaration (FFCD) was provided to the team during the mission and a revised Annex 3 for long term monitoring plan was provided to Iraq by IAEA 13. Other Matters - Detailed examination of equipment at Al Shakili warehouses
Inspection period: from	14-Jul-92	
to	21-Jul-92	
Inspection days	7	
Inspection personnel	9	
Person days	63	
Facilities inspected	5	

Attachment 4 (continued)

Inspection Number	IAEA-14	Activities
Chief Inspector	Zifferero	**Verification of the destruction of all designated buildings at Tarmiya and Al Sharqat was carried out.** Baseline samples of water and sediment were collected to form the basis of an ongoing monitoring regime of radionuclides and other selected stable nuclides in the main water bodies of Iraq. Sites were established covering the whole territory, where water and sediment samples will be periodically collected. **Identification and tagging of a number of high temperature laboratory furnaces and other non-released equipment was undertaken at Al Shakili stores. Follow up activities from previous missions were completed, including transfer of the maraging steel to a foundry in Basra,** and several sites were revisited under the monitoring regime. An underground facility near Al Sharqat was inspected, and confirmed to be an underground oil refinery. Further meetings were held with the Iraqi counterpart with regard to the components of the ongoing monitoring and verification plan. The Iraqi side indicated during this mission that they wanted to work in a cooperative and professional way. Other Matters - Iraqis request release of 250 tonnes of HMX for civilian blasting applications - Refusal to disclose procurement information continues - Refusal to return documents taken from the sixth inspection team
Inspection period: from	31-Aug-92	
to	07-Sep-92	
Inspection days	7	
Inspection personnel	15	
Person days	105	
Facilities inspected	11	

Inspection Number	IAEA-15	Activities
Chief Inspector	Perricos	Collections of baseline samples for the radiometric survey of Iraq's waterways initiated in the previous mission were completed. A detailed assessment of the conditions for removal from Iraq of the irradiated fuel stored at the IRT-5000 reactor and Location B was carried out. **The rendering harmless of the 100 tonnes of maraging steel by re-melting and dilution was completed, as was the destruction of the R24 experimental EMIS magnet system by flame cutting.** Investigations into the role of Rashdiya (Engineering Design Centre) in the centrifuge enrichment programme continued. The Iraqis acknowledged a minor role for the EDC in the centrifuge enrichment programme, and identified the roles of key personnel. Interviews with those individuals resulted in a more credible picture of the Iraqi centrifuge programme. The Iraqi stance with regard to procurement data continued, despite emphasis by the inspection team of the importance of this aspect to the inspection, and ultimately the monitoring process. **Identification and cataloguing of key machine tools in Iraqi establishments continued. The uranium waste material recovered at Al Jesira and moved to Tuwaitha was weighed and sampled and transferred to Location C.** Follow up actions from previous missions with regard to the irradiated fuel storage at Location B were completed. In addition to the water sampling sites, the team visited 29 locations all over Iraq. Other Matters - Baseline radiometric hydrologic survey completed with collection of 572 samples at 52 sites - Technical meetings held with senior technical staff of centrifuge enrichment program - First acknowledgement by Iraq that Rashdiya was connected to centrifuge program - Discovery of centrifuge motor manufacturing equipment in Al Al Shakili stores - Iraqis state that no experiments involving hardware were done at Rashdiya, only computer design work - Analytical results indicate inconsistency in stated nuclear materials processing in Building 73
Inspection period: from	08-Nov-92	
to	18-Nov-92	
Inspection days	10	
Inspection personnel	38	
Person days	380	
Facilities inspected	29	

Attachment 4 (continued)

Inspection Number	IAEA-16	Activities
Chief Inspector	Zifferero	The former headquarters of the Petrochemical-3 project (PC-3), previously visited by IAEA-06 and from where documents relevant to Iraq's nuclear program had been collected, now used by the Military Industrial Corporation, was revisited in conjunction with an UNSCOM-CBW team. Although no activity was observed or documentation found relevant to UN Security Council Resolution 687 (1991), removal of documents from the site by the Iraqis was observed by the inspection team. Other short notice inspections were carried out at an IAEC guesthouse in the Tuwaitha area and at a warehouse in the Al Atheer centre. Meetings with senior Iraqi officials were held to attempt to find a way round the impasse with regards to procurement of the maraging steel and equipment related to the centrifuge enrichment program. The Iraqi Minister of Higher Education and Scientific Research and present Chairman of the Iraqi Atomic Energy Committee informed the team, by formal statement, that the Iraqi authorities would "deal positively" with written inquiries from the IAEA regarding procurement of equipment and materials for Iraq's clandestine nuclear program. A letter requesting specific information regarding the purchase of maraging steel was immediately sent by the Chief Inspector. Iraq's response failed to provide the requested information.
Inspection period: from	05-Dec-92	
to	08-Dec-92	
Inspection days	3	
Inspection personnel	8	
Person days	24	
Facilities inspected	3	

Inspection Number	IAEA-17	Activities
Chief Inspector	Zifferero	Follow up activities with regard to the inventory of material, equipment and machine tools relevant to Annex 3 of the plan for ongoing monitoring and verification of Iraq's compliance with paragraph 12 of part C of Resolution 687 (1991) and with the requirements of the relevant paragraphs of Resolution 707 (1991) were carried out. Particular emphasis was put on the review of the inventory of machine tools under Agency seal at the Al Rabiya factory, following the January cruise missile attack. Follow up activities generated in previous missions with regard to nuclear material stored in the IRT building (Tuwaitha) and in Locations B and C were completed. Short notice inspections to monitor machine tool utilisation and verify seals were undertaken at a number of sites. Discussions regarding Iraqi declarations in the context of Annex 3 were held. The issue regarding Iraq's responses to procurement questions was once more raised during this mission. Iraq's stance was that they wished to have all questions at the same time, in the form of a consolidated list, and would provide the answers in writing and the matter would be settled. The Chief Inspector objected to this and no satisfactory solution was reached.
Inspection period: from	25-Jan-93	
to	31-Jan-93	
Inspection days	6	
Inspection personnel	8	
Person days	48	
Facilities inspected	10	

Attachment 4 (continued)

Inspection Number	IAEA-18	Activities
Chief Inspector	Perricos	Activities concerning the inventory of equipment, materials and machine tools relevant to Annex 3 of the plan for ongoing monitoring and verification were carried out at a number of sites. An inspection at Hatteen Establishment revealed a large number (242) of Matrix-Churchill CNC machines, which the team thought should have been declared in accordance with Annex 3. Specifications were taken to allow this evaluation to be made. A number of sites were systematically searched where information suggested that underground nuclear facilities might be concealed, but the immediate in-field conclusions were negative. A major effort was undertaken to identify and separate a large number of radiation sources, to facilitate easier release of those permitted for use. A number of lengthy technical discussions were held covering areas such as the inadequacies of the Iraq's Annex 3 declarations, nuclear material balance inconsistencies, and Iraqi studies involving uranium tritide. The issue of lithium separation activities and subsequent irradiation was raised by the inspection team. Iraq's response was that this work had never been contemplated, much less carried out. During an inspection of a university in Baghdad, the first inspection of such a facility, Iraq initially attempted to restrict access rights of the team, before changing its position and allowing the inspection to proceed. Once more the issue of procurement was raised, with the same response from the Iraqi counterpart. Iraq stated that they considered the questions too general, and that dealing with them was impractical, and that such an attitude by the IAEA was aimed at maintaining the conditions for continuation of the embargo. Other Matters - Analytical data casts doubt on declared uranium processing activities in Building 73 complex - Six short notice inspections performed as test of long term monitoring procedures
Inspection period: from	03-Mar-93	
to	11-Mar-93	
Inspection days	8	
Inspection personnel	23	
Person days	184	
Facilities inspected	35	

Inspection Number	IAEA-19	Activities
Chief Inspector	Hooper	A major activity was the collection of surface water, sediment and biota samples from 15 locations along the Tigris-Euphrates watershed, for the periodical radiometric survey. Work continued into the verification of Iraqi information given in their Annex 3 declarations, and a number of sites were visited for the first time with a view to verifying the completeness of the Annex 3 declarations. Detailed technical evaluations of a large number of Matrix Churchill machine tools at Hatteen Establishment were carried out to establish whether or not these machines should be included in Iraq's declarations, with the result that, pending further investigation on 4 of the machines, none of these machines meet the specifications of Annex 3. An additional 50 or so Matrix-Churchill CNC machines remained in other facilities to be similarly reviewed. Additionally, monitoring inspections were carried out at a number of sites previously visited.
Inspection period: from	30-Apr-93	
to	07-May-93	
Inspection days	7	
Inspection personnel	14	
Person days	98	
Facilities inspected	33	

Attachment 4 (continued)

Inspection Number	IAEA-20	Activities
Chief Inspector	Kelley	Iraq's preparations for the removal and transport to the airport of the irradiated fuel were observed, and several meetings held to discuss the preparation status. Fuel storage conditions at Location B were rechecked for safe condition. Acting upon independent information at their disposal, the teams inspected a conventional munitions plant where 50 Matrix-Churchill CNC machines matching procurement data were found. Details to allow the assessment as to the relevance of these machines to Annex 3 were obtained. Iraq's construction and planning activities for new non-nuclear facilities at four former nuclear sites were assessed. Preparations for the consolidation of all HMX explosives into a single sealed location were started, and the team inspected a proposed alternative storage area in Muthanna. A number of sites were visited with regard to dual-use equipment inventorying and monitoring tasks. Milestones and decision points of Iraq's feasibility studies for protected underground facilities and the project to acquire a nuclear power plant were reviewed in discussion with the counterpart. The idea of going underground to protect nuclear installations was abandoned in 1983, due to the "astronomical" costs associated with this route, following assessments made by a number of international companies. The need for full cooperation on the issue of procurement was stressed to Iraq, and Iraq was challenged to release supplier information on a specific program, as a confidence building gesture. Other Matters - Additional 50 CNC machines discovered at Nahrawan facility
Inspection period: from	25-Jun-93	
to	30-Jun-93	
Inspection days	5	
Inspection personnel	10	
Person days	50	
Facilities inspected	10	

Inspection Number	IAEA-21	Activities
Chief Inspector	Zifferero	The activities started in IAEA-20 were continued. A new industrial complex of five separate facilities at South Taji was inspected for the first time, where several dual-use materials were found to be in use. Preparations for the installation of surveillance cameras at machining facilities continued. The Al Kindi centre, which has unique capabilities for research with pyrotechnic materials, was inspected. A number of sites were visited with regard to dual-use equipment inventorying and monitoring tasks. The issue of procurement raised by the previous mission was tabled once more, and the Iraqi Minister of Higher Education and Scientific Research said he was not prepared to hand over any information to the team. He did, however, promise to provide the information at the "technical talks' scheduled some two months later in New York. Overall, the inspection ran smoothly and the Iraqis were helpful throughout. Other Matters - Discovery of a "Centre for Metallurgical Industries" during inspection of fibreglass plant in Taji - IAEA orders work on the Al Jesira iron oxide plant to stop until documentation is provided by Iraq
Inspection period: from	24-Jul-93	
to	27-Jul-93	
Inspection days	3	
Inspection personnel	16	
Person days	48	
Facilities inspected	21	

Attachment 4 (continued)

Inspection Number	IAEA-22	Activities
Chief Inspector	Hooper/Dillon	A major activity was the collection of surface water, sediment and biota samples from 15 locations along the Tigris-Euphrates watershed, for the periodical radiometric survey. Further progress was made in clarifying, with the Iraqi counterpart, the reporting requirements of Annex 3 of the IAEA's ongoing monitoring and verification plan and the reconciliation of Iraqi equipment declarations with information obtained outside of Iraq. Meetings were held with the Iraqi counterpart on the subject of technical advice they had obtained from sources outside of Iraq that had aided their centrifuge development efforts. With reference to the procurement of maraging steel, Iraq indicated some general details and identified an individual as their agent. They maintained they did not know the manufacturer, but offered speculation on the nation of origin based on circumstantial evidence. Details regarding the sources and circumstances through which they obtained technical advice from outside Iraq were provided to the team. Detailed analysis were performed on the UO2 contained in 201 drums declared by Iraq to have come from Brazil, to enable the accuracy of this information to be verified. Preliminary findings, pending chemical analysis, indicated that the material was not indigenous to Iraq, nor was it the result of an Iraqi UO2 production process. Monitoring inspections were carried out at a number of so-called "core" sites of the former Iraqi nuclear program. Existing building modifications, new construction and future plans for turning several of the facilities to other, non-nuclear applications, were reviewed. **A follow up action from a previous mission, to fill and seal the carbonate mine at Abu Skhair, was completed.** Other Matters - IAEA concludes that all unsafeguarded nuclear material processing done in the Building 73 complex was done in Buildings 73 A and 73B, not in building 73C as declared by the Iraqis
Inspection period: from	01-Nov-93	
to	15-Nov-93	
Inspection days	14	
Inspection personnel	17	
Person days	238	
Facilities inspected	41	

Attachment 4 (continued)

Inspection Number	IAEA-23	Activities
Chief Inspector	Dillon	Monitoring inspections were carried out at a number of sites with previous nuclear or nuclear-related missions, as well as at sites where equipment relevant to Annex 3 exists. Substantial progress was made in verifying the inventory of the Matrix-Churchill CNC turning machines imported into Iraq and in determining whether any of these machines were of a quality that would require their declaration and monitoring in accordance with Annex 3, with the conclusion that none were of such quality. A number of sites declared to have power supplies exceeding 10MVA were inspected. Further progress was made in clarifying, with the Iraqi side, the reporting requirements of Annex 2 of the IAEA's ongoing monitoring and verification plan. The work started in the previous mission with regard to the Brazilian origin UO2 was continued, the results of which, whilst awaiting corroboration of the Brazilian Government, supported a conclusion that the material was of Brazilian origin. Additional non-destructive assay measurements and samples of other material were taken to clarify issues regarding the inventory of nuclear material. The surveillance camera system was installed in the "vertical boring machines workshop" at Um Al Maarik, to provide a means of continual monitoring of the nature of work pieces processed in that workshop. Verification of the inventory of "sensitive" components of the Tamuz reactors was carried out, and Iraq's explanation of the loss mechanisms relating to the heavy water inventory was accepted as credible by the team. The conclusion of the team was that all of the sensitive components of the Tamuz-1 and 2 reactors had been satisfactorily accounted for. A number of ground level gamma spectrometric measurements were made at several facilities with the purpose of clarifying previous readings. Preliminary conclusions were that radiation signals detected were probably due to accumulated radioactive waste, radioactive contamination as a result of the bombing during the Gulf war or to high intensity sources used in lightning rods. **The second and final consignment of irradiated fuel was shipped out of Iraq.** Other Matters - Some 272 out of a possible 280 Matrix-Churchill CNC turning machines have been located and examined - Additional nuclear material (Al Jesira waste) arrives at Location C for storage
Inspection period: from	04-Feb-94	
to	11-Feb-94	
Inspection days	7	
Inspection personnel	17	
Person days	119	
Facilities inspected	41	

Attachment 4 (continued)

Inspection Number	IAEA-24	Activities
Chief Inspector	Dillon	A major activity was the collection of surface water, sediment and biota samples from 16 locations along the Tigris-Euphrates watershed, for the periodical radiometric survey. Discussions were held with the Iraqi counterparts on the form and content of the inventory reports prepared by Iraq in accordance with paras 22 and 23 of the OMV plan, and inspections at a number of facilities were carried out with the purpose of clarifying details in these reports. Inspections were also carried out at facilities where machine tools, subject to monitoring in accordance with Annex 3 of OMV were installed or stored, for similar purposes. These "test case" inspections indicated that information provided for design capabilities and activities was minimal and would require further revision by the Iraqis. Activities were carried out in connection with the planned installation of a 10-camera video surveillance system in the flow-forming workshop at Nassr. A large number of plant items from the former uranium extraction plant at Al Qaim were examined in order to process a request for their release for use elsewhere on the site. Activities were carried out at Al Jesira and Al Adaya sites to determine uranium content of holding tanks and scrapped equipment. A holding tank at Al Jesira, along with other items of scrapped equipment, were inspected to evaluate their uranium content. Preliminary findings supported Iraqi statements that large processing losses were accountable as waste. Other Matters - Excavation of Adaya dump to investigate uranium content of scrapped Al Jesira equipment - Building 73 filter banks located by Iraqis and presented for inspection
Inspection period: from	11-Apr-94	
to	22-Apr-94	
Inspection days	11	
Inspection personnel	15	
Person days	165	
Facilities inspected	39	

Inspection Number	IAEA-25	Activities
Chief Inspector	Dillon	Inspections were carried out at sites where items of equipment subject to monitoring in accordance with Annex 3 of the OMV plan were located, and at sites with previous nuclear or nuclear related missions. During the inspections at former nuclear related sites, the adequacy of the information supplied by Iraq in the OMV reports was assessed. In general, this information was found to be lacking in detail in areas of past and present design capabilities and activities. Work continued on the clarification of matters related to the origin and usage of natural uranium and on the characterisation of the UO2 of declared Brazilian origin. Additional samples were taken. The discrepancy between the IAEA's and the Iraqi counterparts analysis of uranium content in waste material from the Al Jesira evaporation tank was investigated, with the conclusion that there was no reason to change the IAEA estimate of the amount of uranium in the waste. Additional samples were taken to confirm previous IAEA analyses and to check results obtained by the counterpart. The installation of a 10-camera surveillance system at Nassr, in the flow-forming workshop, was completed. An additional camera was installed at Um Al Maarik to augment the existing system. Members of the team participated in an UNSCOM inspection of the Al Rutbah telecommunications site. Extensive discussions were held with the Iraqi counterpart in regard to quality and content of reports prepared in accordance with paras. 22 and 23 of the OMV, and Iraq was asked to provide more comprehensive information in areas lacking detail. Detailed inspections were made of equipment and non-nuclear material in use or in store in Tuwaitha and Al Shakili store, in order to reconcile the IAEA inventory lists and the building inventories reported by Iraq in the OMV reports.
Inspection period: from	22-Jun-94	
to	01-Jul-94	
Inspection days	9	
Inspection personnel	12	
Person days	108	
Facilities inspected	24	

Attachment 4 (continued)

Inspection Number	IAEA-26	Activities
Chief Inspector	Dillon	Investigations were carried out, principally at Tuwaitha site, into Iraq's former activities in the laser isotope separation (LIS) area, covering the procurement and development of laser equipment and research in both molecular (MLIS) and atomic vapour (AVLIS) laser isotope separation technologies. The investigation resulted in an admission by Iraq, that contrary to previous written statements, they had, during the period 1981 to 1987, assigned resources to the task of exploring the feasibility of LIS, as a means of producing enriched uranium. Visits to several sites, including the Laser Department at Baghdad Technical University were made in connection with the investigation. The task appeared to have been poorly focused and its limited achievements appeared to be consistent with the equipment, personnel resources and expertise available. Inspections were also carried out at sites where items of equipment subject to monitoring in accordance with Annex 3 of the OMV plan were located, and at sites with previous nuclear or nuclear related missions. Further inspections were carried out at a number of sites with power supplies declared in excess of 10 MVA. Discussions were also held with the Director of the Iraqi National Monitoring Directorate (NMD) on the status of the preparations for the implementation of the OMV plan. Concurrently with this mission, the IAEA established its continuous presence in Iraq in connection with the implementation of OMV. Other Matters - Al Qaim yellowcake production log book provided showing analytical data
Inspection period: from	22-Aug-94	
to	07-Sep-94	
Inspection days	16	
Inspection personnel	18	
Person days	288	
Facilities inspected	16	

Inspection Number	IAEA-27	Activities
Chief Inspector	Dillon	Following the establishment of a permanent IAEA presence in Iraq, the main activity of this mission was to provide additional staffing for the major activity of the collection of surface water, sediment and biota samples from 16 locations along the Tigris-Euphrates watershed, for the periodical radiometric survey. In addition, activities were undertaken with the resident IAEA team in the routine inspections at Iraq's industrial and scientific establishments subject to monitoring under the OMV.
Inspection period: from	14-Oct-94	
to	21-Oct-94	
Inspection days	7	
Inspection personnel	8	
Person days	56	
Facilities inspected	30	

Attachment 4 (continued)

Inspection Number	IAEA-28	Activities
Chief Inspector	Dillon	Investigations into information given by the Iraqis at the technical talks in Baghdad during August 1995, regarding the withholding of information from the IAEA concerning the crash program, were undertaken. According to the Iraqi counterpart, the crash program had been planned to comprise tasks involving the reprocessing of both the unirradiated and irradiated fuel to recover HEU, the re-enrichment of the 80% enriched material of Russian origin, through the use of a 50 machine gas centrifuge cascade specially constructed for the purpose and the conversion of the HEU compounds to metal. Other activities, namely casting and machining of the HEU to form the pit of a nuclear weapon, weaponisation measures including the design of an implosion package, and construction of a test site/delivery system were established activities of the fourth group of the PC-3 project, and were stated to be moving ahead at the fastest rate possible. For the first time, Iraq acknowledged that the activities of the fourth group, initially at IAEC, Tuwaitha and later in Al Atheer, were for the direct purpose of producing nuclear weapons. An admission was gained as to the processing of undeclared nuclear material in the former Fuel Fabrication Laboratory at Tuwaitha. The Iraqis finally admitted that the EDC Rashdiya facility was the headquarters of the centrifuge enrichment project, but could provide no credible explanation for their continued concealment of this fact. Wide ranging information regarding procurement systems to support the centrifuge project were obtained. It was recognised by the team that although there are no indications that Iraq had retained any practical indigenous capability to produce weapons usable nuclear material, Iraq's intellectual capabilities and resources in this regard remain. In discussion, Iraq was forthcoming to an unprecedented degree and demonstrated an apparent sense of relief at being able to talk about matters that they had previously either denied or for which they had persisted to defend explanations of highly questionable credibility. There were however indications of reticence typified by their continued understatement of the competence of the management of its clandestine nuclear weapons program and of the capabilities of its scientists and engineers.
Inspection period: from	09-Sep-95	
to	20-Sep-95	
Inspection days	11	
Inspection personnel	15	
Person days	165	
Facilities inspected	5	

Attachment 4 (continued)

Inspection Number	IAEA-29	Activities
Chief Inspector	Stokes	This inspection was carried out to pursue further the information revealed by the Iraqi authorities after the departure of Lt. General Hussein Kamel from Iraq, and was a continuation of the inquiries began during IAEA-28. Further detailed discussions were held with the Iraqi counterpart to discuss technical and programmatic details and the organisational structure of the centrifuge enrichment program. Inspections at appropriate facilities, such as Al Furat and EDC Rashdiya were undertaken, with the involvement and organisation of these facilities with regard to the program discussed. Amongst the information given were code numbers to designate the different centrifuge models, along with some indication of design variations. The Iraqis admitted to having almost a complete set of drawings of a 3 metre long supercritical machine, and had incorporated building modifications at EDC in the eventuality of this machine becoming available. Other areas visited were procurement and foreign assistance, during which Iraq admitted to having attempted to obtain bellows production technology for the supercritical machine, and had received samples of bellows, baffles and pins from their foreign consultant. In the area of weaponisation it became clear that the original program objective was an arsenal of weapons with the first operational device by 1991. However, the three main components of the program, namely the production of HEU from domestic sources of uranium, design of a viable device and development of a delivery system, had not progressed equally. The weapon design was the closest, and, in the opinion of Iraq, in January 1991 may still have been able to meet the original deadline. On the last day of the mission the team was presented with an optical disk on which reports from PC-3 Fourth Group (weaponisation), dated from 1988-1991, were stored. As during IAEA-28 the Iraqis displayed a remarkable level of openness in the discussions, although there was some variation from subject to subject and individual to individual. Degrees of reticence however appeared to remain and the impression persisted that the process to approach the full truth on some parts of their programme-centrifuge enrichment being a typical example-still had some way to go. It was not clear if this was due to individual fears of mid-level officials or is part of a plan aimed at protecting information, equipment and materials.
Inspection period: from	17-Oct-95	
to	24-Oct-95	
Inspection days	7	
Inspection personnel	13	
Person days	91	
Facilities inspected	3	

Attachment 4 (continued)

Inspection Number	IAEA-30.1	Activities
Chief Inspector	Dillon	Technical discussions were held on FFCD chapters concerning: laser isotope separation, nuclear material, gaseous diffusion, centrifuge enrichment, nuclear weapon development and the summary and concluding chapters of the document. In all some 300 substantive additions and revisions to the text were requested and agreed to be undertaken by the Iraqi counterpart. It was agreed that discussions on the EMIS program would be scheduled for June 1996 and that all revisions and additions would be incorporated into a second draft of the FFCD.
Inspection period: from	13-May-96	
to	19-May-96	
Inspection days	6	
Personnel	12	
Person days	72	
Facilities visited	none	

Inspection Number	IAEA-30.2	Activities
Chief Inspector	Zifferero	A revised version of the FFCD coded FFCD (F-1) was provided by the Iraqi counterpart under cover of their letter dated 20-Jun-96. This revision was stated to include the revisions and additions arising from the May discussions as well as revisions to the chapter dealing with EMIS incorporating responses to the written comments – some 50 in number - provided by the IAEA by letters of 23 and 24 May 1996. Iraq's responses to these written comments were reviewed in a series of 5 discussion sessions and it was agreed that further revisions and additions would be incorporated into the text of the FFCD. On 17 September 1996 received in Vienna a revised version of the FFCD coded FFCD-F which Iraq considered to be the final version of the FFCD. FFCD-F was stated to contain all of the revisions and additions that had been brought to Iraq's attention by the IAEA.
Inspection period: from	24-Jun-96	
to	29-Jun-96	
Inspection days	5	
Personnel	4	
Person days	20	
Facilities visited	1	

Inspection Number	IAEA-30.3	Activities
Chief Inspector	Dillon	In parallel with Nuclear Monitoring Group activities, discussions were held with the Iraqi counterpart to follow-up on matters arising from further review of FFCD-F. These matters – some 42 in number - had been transmitted to the Iraqi counterpart by letter of 13 January 1997 which had responded by letter dated January 27 1997. In the course of discussion a further 25 matters were raised and the Iraqi counterpart agreed to address all matters and to incorporate them in a consolidated list of additions and revisions which would eventually be incorporated into FFCD-F. In addition the Iraqi counterpart undertook to provide a detailed description of the strategy, units responsible, locations, logistics and chronology of events involved in the concealment and destruction activities. Iraq's written response was received by letter dated 26 February 1997.
Inspection period: from	05-Feb-97	
to	07-Feb-97	
Inspection days	2	
Personnel	3	
Person days	6	
Facilities visited	2	

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Attachment 4 (continued)

Inspection Number	IAEA-30.4	Activities
Chief Inspector	Dillon	Clarification was obtained to a number of Iraq's written responses to the matters raised in the February 1997 discussions and the IAEA team provided detailed comments on Iraq's chronology of concealment and destruction activities. The focus of the discussions was however on endeavours to gain information to support Iraq's declaration that it had indeed abandoned its clandestine nuclear programme on acceding to UNSC resolution 687 in April 1991. In this context and at the request of the IAEA, Iraq made presentations on the evolution of its strategy for the protection, concealment, salvaging and unilateral destruction of materials, equipment, documents and buildings related to its clandestine nuclear programme; the progress in the design and development of Iraq's nuclear weapon after the version reported in Petrochemical Project 3 (PC-3) Report 821, Revision 5, dated 14 July 1990 (including the post-war plan to misrepresent the mission of the Al Atheer nuclear weapons development and production facility); and the evolution of the abandonment of the former nuclear weapons programme. In the course of discussions the Iraqi counterpart undertook a number of actions most notably to make a serious effort to locate items of equipment formerly assigned to PC-3 Group 4 (weaponisation)
Inspection period: from	16-May-97	
to	22-May-97	
Inspection days	6	
Personnel	12	
Person days	72	
Facilities visited	none	

Inspection Number	IAEA-30.5	Activities
Chief Inspector	Dillon	Again a small number of technical clarifications to the text of the FFCD-F were obtained and the Agency team was able to verify a number of items, formerly assigned to PC-3 Group 4 (weaponisation), which the Iraqi counterpart had been able to locate. However the main focus of the discussions was to seek to ascertain (a) that Iraq had abandoned, rather than merely interrupted, its clandestine nuclear programme; (b) that Iraq had provided comprehensive information with respect to its gas centrifuge uranium enrichment programme, its nuclear weapon design and its achievements in associated technologies; (c) that Iraq had explained the extent of foreign assistance to its clandestine nuclear programme, including the role of intelligence services in procuring assistance, information, materials, and equipment; (d) that Iraq had provided a comprehensive explanation of the extent and objectives of its concealment practices; and (e) that Iraq is no longer concealing equipment, materials and documentation from the IAEA.
Inspection period: from	19-Jul-97	
to	24-Jul-97	
Inspection days	5	
Personnel	8	
Person days	40	
Facilities visited	1	
